POWER

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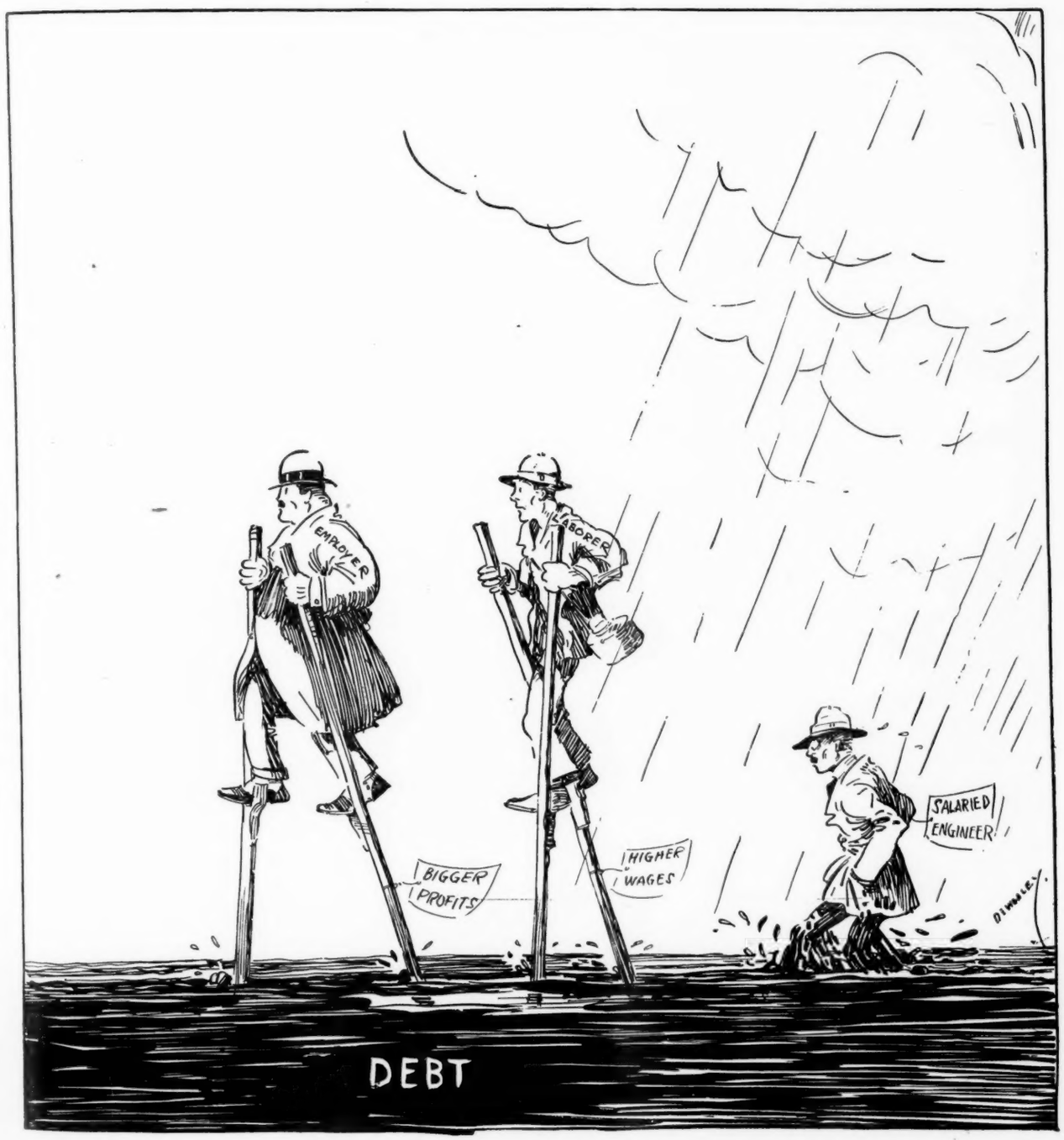
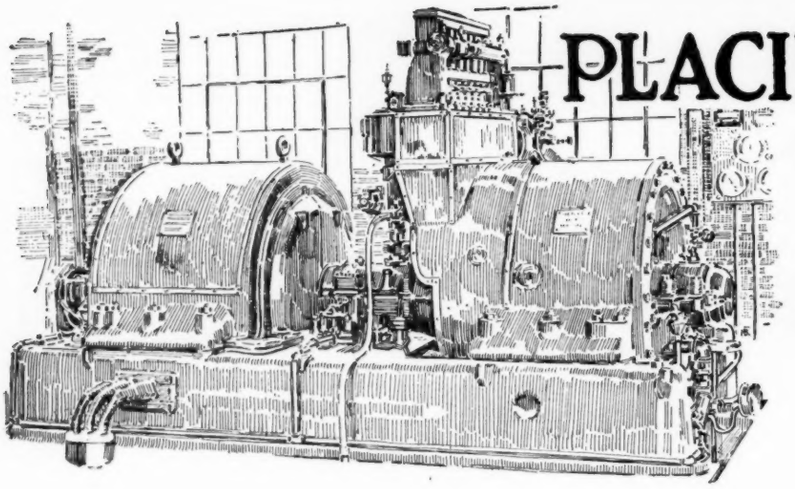




PLACING A NEW TURBINE *in* SERVICE

By Roger Taylor

The procedure followed in putting a steam turbine into service for the first time is discussed. Such features as leveling, alignment, checking bucket clearance, adjustment of thrust and step bearings, valve setting and governor adjustment are considered.

SETTING up and assembling of a new power-plant unit should be followed carefully by the operating force of the station, because the satisfactory operation of the machine in regular service will be so much more assured if some previous knowledge of it has been gained. Besides, the erecting engineer is usually qualified to give the operating engineer many suggestions regarding the unit as a result of his familiarity with every part of it.

The erection of a turbine unit begins with the setting of the base upon its foundation. The base is raised three-quarters to one inch from the foundation by means of wedges and distance pieces (Fig. 1) placed three or four feet apart under the base, to provide space for the final grouting after the unit has been satisfactorily lined up. The bearing pedestals are set in position, and by means of a line stretched through the bearings the alignment is checked and adjustments made by means of shims. With a slightly lower setting there, allowance is made for the effect of temperature upon the alignment of the steam end of the set. The generator bearings are customarily set slightly higher than the others, to bring any movement of the field toward the coupling rather than away from it.

After the leveling and alignment are satisfactory, the generator stator and other heavy parts are put in place, foundation bolts are tightened and the alignment is once more checked. Grouting is accomplished by raising a wall around the base on the foundation, as shown in Fig. 1, extending this wall far enough above the bottom of the base so that the grout mixture, when poured, will form a solid foundation.

When the generator field and the rotating element of the turbine are in place, the line-up of the coupling is checked. Care must be used here. The coupling should be checked between faces by using a taper gage (shown at *D* Fig 2), at several points around the coupling. By using a straight-edge along the edge of the coupling, as at *A* and *B* in the figure, the flanges may be checked. Perfect alignment must be obtained throughout the two spindles in order to reduce to a minimum the strains at the coupling. Other important points in the assembling of the unit are the adjustments of clearance, thrust bearing, valve motion and governor mechanism. The operating force should understand these adjustments, since later on, during the regular operation of the unit, they will be required to make periodic checks on the clearances and the wear on the thrust bearing.

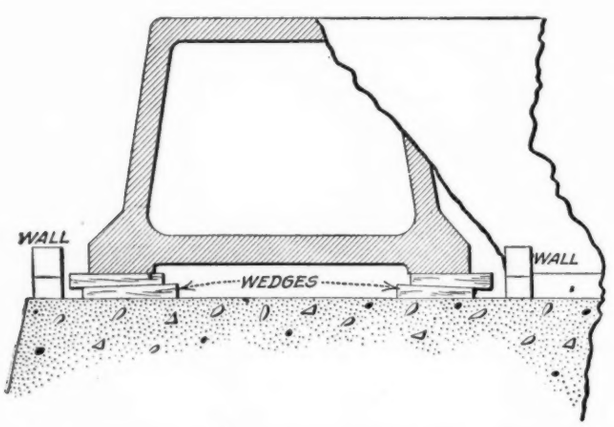


FIG. 1. METHOD OF SETTING BASE ON FOUNDATION

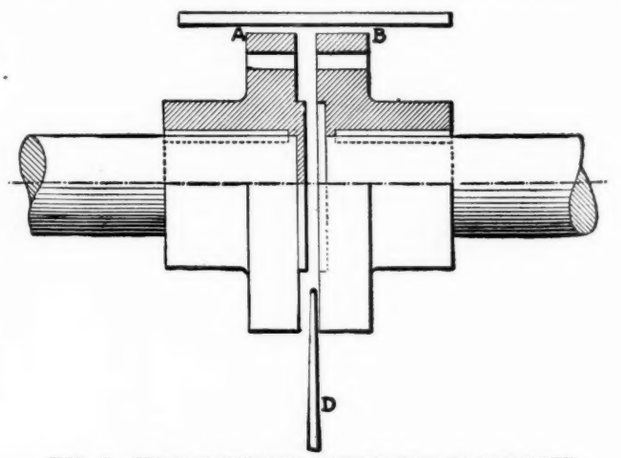


FIG. 2. HOW COUPLING ALIGNMENT IS CHECKED

In the Curtis turbine the clearance is equally divided on each side of the revolving buckets, or at least within the few thousandths of an inch permitted by the thickness of the material used for liners, the total clearance to be so divided varying with the size of the unit. The thrust bearing is so adjusted that a certain amount of movement, or float, of the spindle is possible—usually 0.0010 to 0.0015 in. Whatever design of thrust bearing is used, its purpose is to limit to a definite amount the movement of the spindle in either direction; so that with any given amount of float in the thrust the clearance between the stationary and the revolving bucket elements will be sufficient to prevent striking or rubbing. Owing to the wear on the faces of the thrust collars, the float of the spindle will be increased after a period of running, even with the best of lubrication. If the blade clearances are not correctly adjusted, serious damage to the blading from rubbing will result.

In the Parsons turbine, using dummy or balancing pistons on the rotor, as in Fig. 3, there is little rotor end thrust. Thrust-bearing adjustment is made to bring the balancing piston into the position that reduces to a minimum the leakage from piston to piston; allowing 0.008 in. to 0.015 in. float to give freedom to the collars revolving in the thrust boxes. The function of the balancing piston is to exert a balance against the pressure of the steam on the rotor, which otherwise would be forced into the direction of the steam flow. By this means end thrust is eliminated. Each succeeding drum of the rotor to which the blades are attached is made larger in diameter to accomodate the increased volume of the steam due to expansion. By means of an equalizing pipe each drum is connected to a balancing piston of corresponding area in such a manner that pressure is exerted on the piston in the opposite direction to the pressure on the drum. The thrust bearing consists of two cast-iron bodies having brass collars

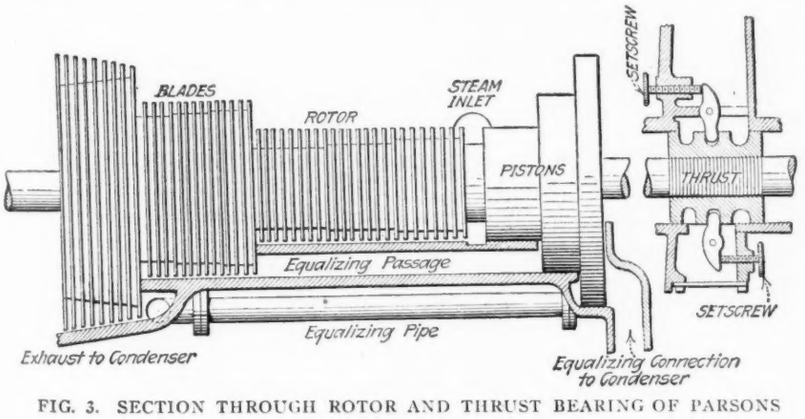


FIG. 3. SECTION THROUGH ROTOR AND THRUST BEARING OF PARSONS TURBINE

running in grooves on the shaft, as shown in the figure. The positions of the thrust blocks are set by means of two screws on the outside of the pedestal, one for each half of the block. The upper block is adjusted by its screw so that the labyrinth packing strips of the piston barely touch the labyrinth rings in the cylinder casing. The lower half of the block is then adjusted in the opposite direction to give the necessary float for the collars of the thrust.

Fig. 4 shows one of the many types of thrust bearings used on the smaller machines. On each side of the bearing proper is a set of thrust collars consisting of two hardened steel plates, 1 and 3, and a roller collar, 2. Between the bearing and plate 3 are horseshoe rims, or liners, of sufficient thickness to give the necessary float. After the required float has been determined, the liners are divided on each side of the bearing to bring the blade clearances approximately equal. On this type of thrust all adjustments must be made with the bearing covers removed.

With the type of thrust bearing shown in Fig. 5, after the float adjustment has been made the thrust

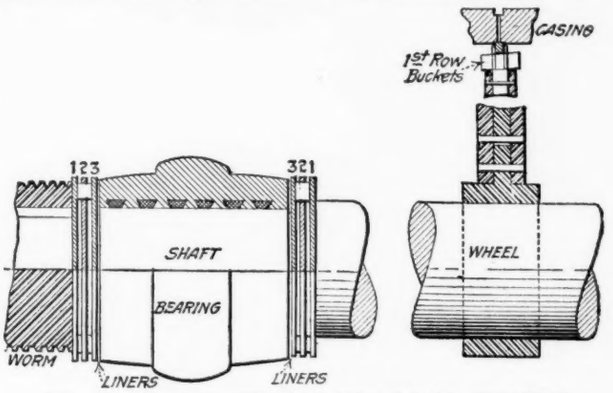


FIG. 4. THRUST BEARING FOR SMALL TURBINE

position relative to the blade clearance can be changed with the bearing covers in place, by means of the worm shaft shown; although the covers must be removed periodically to inspect the float adjustment and to apprehend undue wear on the roller plates. In the vertical machine the thrust arrangement is materially different. Owing to the fact that the whole revolving element of the unit must be supported and always held at the same height in order to maintain the correct clearance between the stationary and revolving buckets, a bearing known as the "step" bearing is employed.

The essential parts of the step bearings, shown in Fig. 6 are the bearing blocks B and B'. The lower block B is held stationary by a key at one side and is supported at a given height by the large adjusting screw S passing through the center of the cover plate. The upper block B' is fastened to the turbine spindle T with which it is made to revolve by a key in the center of it and a dowel at either side. The upper face of this block is counterbored to fit the spindle. A fluid for lubrication, either oil or water, is fed through a pipe P inside the adjusting screw to the recessed space shown between the two blocks. By means of the adjusting screw the position of the revolving wheels relative to the stationery wheels is changed.

To facilitate the checking of the wheel clearances, a hole is made in the turbine casing opposite the first-stage wheels, for the insertion of the taper-gage, as shown in Fig. 7. With a thrust bearing having outside adjustments, such as the one in Fig. 6, the clearances may be taken with the machine rotating. To do so, the spindle is raised by means of the adjusting screw, until a slight rub is noticed on the wheels, then the screw is backed off until a similar rub is noticed in the opposite direction, and halfway between the two rub-

bing points is taken as the center of clearance. Such an adjustment must be made with extreme care, and at the first indication of rubbing, the adjusting screw must be backed off to move the spindle in the opposite direction.

The important item in setting the valve motion and governor mechanism is to so adjust the pilot valve that all valves are open when the unit is at rest; and to

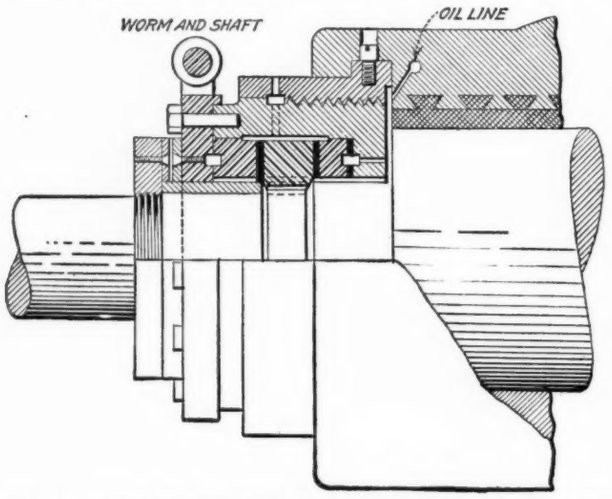


FIG. 5. THRUST BEARING THAT CAN BE ADJUSTED BY A WORM AND GEAR

limit the travel of the valve-cam rack to that point in order that no overtravel may occur and that all valves will be open when the unit is at maximum load. When the unit is at speed but without load, no valves should be fully open and only one partly open to maintain speed; in other words, the unit must be under governor control. No serious wiredrawing of the steam will then occur, because all the valves except one must always be in either a wide-open or closed position. Overtravel of the camshaft, with its consequent locking of the mechanism, may be prevented by blocking under the piston, which operates the camshaft through the rack, so as to give no more than a full cam travel. Usually, this is taken care of in the design of the machine by a device such as the hydraulic cylinder, shown in Fig. 9. The valves are of the globe type, Fig. 8, and are opened by the cam raising the lever against the tension of the compression spring. Sufficient tension must be given the compression spring on the valve lever to restore the valve solidly to its seat.

Although all governor adjustments are made at the factory, further adjustments usually will be necessary on the governor spring tension to obtain the desired speed range. This adjustment is made on the tension nut of the main spring. After the assembly of the governor the various rods and levers to the pilot valve are connected and the pilot valve is brought to its normal position. Being without lap, the correct position of this valve is directly opposite the port openings to the hydraulic cylinder.

The governor and valve operation may be seen from Fig. 9. When the turbine is at rest, all valves are open, the hydraulic piston at the end of its stroke and the pilot valve in its mid-position relative to the ports. As the unit approaches the speed at which the centrifugal force of the governor weights overcomes the tension of the main-governor spring, the governor beam connected to the spindle will be lowered and, by its connection to the floating lever of the pilot valve, will lower this valve in its bushing. As this valve has no lap, the slight downward movement will open the top port over the piston to exhaust and the bottom port to allow the oil to pass under and raise the piston. By means of its connection to the pilot-valve piston rod through the floating lever, the outer end of which forms a fulcrum on the connecting-rod to the governor beam, this slight raising of the hydraulic piston restores the pilot valve to its original position of closing the ports. The raising of the hydraulic piston will have rotated the valve camshaft enough to partly close the valves. Should this movement be insufficient and the unit continue to accelerate, the operation will be repeated until only enough valves are open to maintain the proper speed.

Similarly, a reduction in the speed of the turbine will raise the governor beam and pilot valve, thus lowering the hydraulic piston and opening the valves. The pilot valve, while directly under the control of the governor, is limited in its travel by the hydraulic piston through the floating lever. Any movement of the governor weights immediately results in a slight movement of the pilot valve, which in turn causes the position of the piston to be changed, reacting on the pilot valve and restoring it to its mid-position. In the operation of the unit lost motion in the governor mechanism must be kept at a minimum so that immediate response will be made to any change in speed. The governor transmission bearing should be cleaned frequently to obviate the possibility of sticking.

When the assembling of the unit, with its auxiliaries, its steam, oil and water piping, has been completed, preparations will be made for the initial run. The

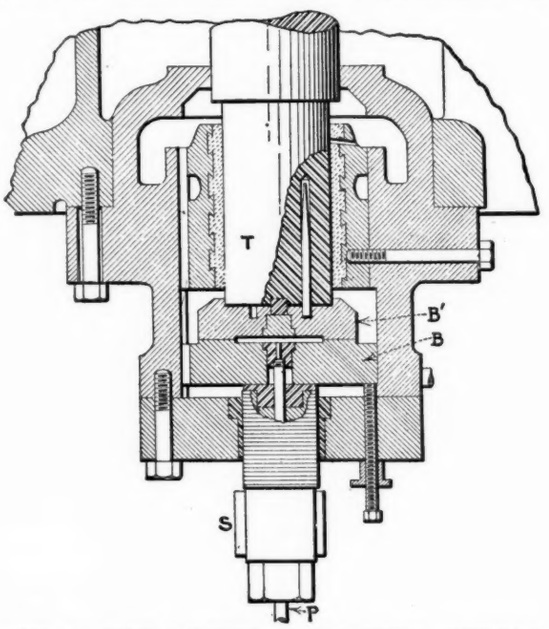


FIG. 6. STEP BEARING FOR VERTICAL TURBINE

steam line will be blown out, up to the screen, which should be placed ahead of the throttle valve so as to clean the steam lines of scale and foreign matter. An inspection is made to insure that the camshaft bearings, the rollers of the valve gear and the governor-transmission bearing have been properly lubricated. The lubrication system will be checked and the proper quantity of turbine oil placed in the oil reservoir. The

oil system will be tried out by starting the auxiliary oil pump, which is always used in starting the unit, so that the bearings may be lubricated by it until the speed of the unit is sufficient for the main oil pump to supply the lubrication. The auxiliary oil pump should be controlled by a pressure regulator in the steam line and its throttle open, so that in the event of failure of the main oil pump, the lubrication will

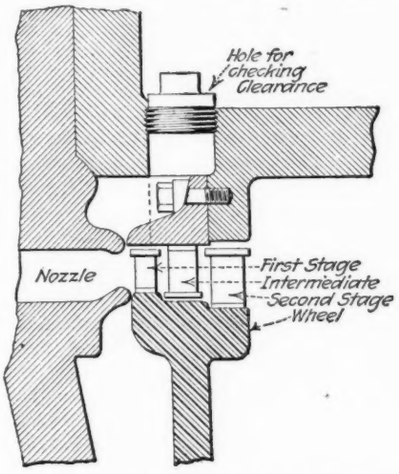


FIG. 7. HOLE IN CASING FOR CHECKING CLEARANCE

be at once taken care of, before damage can result. The relief valve from the oil lines exhausting into the oil tank is adjusted to give the correct pressure in the governor's hydraulic cylinder, which is approximately 75 lb. The step-bearing pressure will be adjusted by the baffler reducing valve, the bearing water-cooling system tried for water leaks into the oil system. Inspection will be made to determine that the screens are in place over the oil suction in the tank. Inspection will also be made of the steam lines to the carbon packing of the seals, to see that they are connected and the valves adjusted.

While a general survey is being made to see that all tools, forms and blocking have been removed, the unit may be heated by passing a small quantity of steam through it for a short time, and the auxiliaries started up. For some time after being first turned over, the unit is run at reduced speed, and during this time careful watch must be kept on all parts of it, particularly the bearing temperatures.

When the speed of the unit is being increased, attention must be given to its balance. Although the turbine wheels and generator rotor were balanced at the factory, this balance may have suffered during shipment or erection. When a unit shows considerable unbalance, it is sometimes necessary to disconnect the coupling and remove the generator's rotor while the turbine's rotor is being balanced; after which the generator's rotor is replaced and the unit balanced as a whole until it is satisfactory at all speeds.

As the unit approaches full speed, the governor action must be noted to see that all valves are opening and closing properly and that the unit is under control. If the valve action does not take place at the proper speed and the pilot-valve and camshaft adjustments were properly made, the speed of the machine must be lowered by decreasing the tension on the main governor spring; while if the unit comes under governor action before it is at speed, this tension must be increased. Ordinarily, the governor weights and springs under tension are so nearly correct for the desired speed that there is ample room on the mainspring nut for any adjustments necessary, which should be within a narrow range. During these speed tests the auxiliary synchronizing spring should have its bottom plug at about mid-stroke. The governor-speed range test should now be taken, to ascertain the effect on the speed of the unit exercised by the auxilary synchronizing spring.

The unit having thus far satisfactorily operated, a test is made on the overspeed device for tripping the automatic throttle. This test is made by bringing the unit 8 or 10 per cent. above normal speed, by closing the oil supply to the hydraulic cylinder, causing all valves to remain open. The machine is brought to speed and allowed to accelerate until it is at 8 or 10 per cent. overspeed. Should the tripping device fail to operate then, the throttle must be tripped by hand and the unit brought to rest. The tension of the spring may then be reduced, and the overspeed trial repeated until the trip operates at the desired point. This device is so important as to deserve constant attention to insure that it is in proper working order and that the unit is free from the danger of overspeed.

Soon after the unit has carried load, a complete record should be made of its economic conditions and the results checked against those guaranteed by the manufacturer. With a steam-flow meter on the main-steam line and thermometers located at essential points —the steam-line and steam-exhaust outlet, the injection-water inlet and discharge, the air-pump suction and discharge, and, if a surface condenser, on the hotwell—

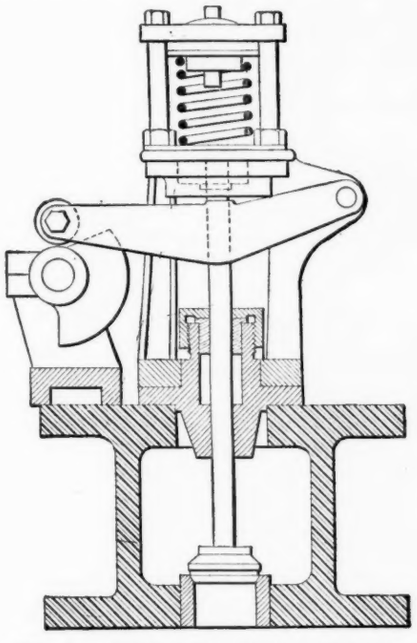


FIG. 8. SECTION THROUGH STEAM TURBINE VALVE

these instruments together with those on the switchboard will enable the operator to check the steam consumption of the unit against its load and thereby ascertain how closely the actual performance of the machine approaches its guarantees. Particular note must be made of the vacuum to see that the back pressure is kept at the proper figure. All exhaust piping should be checked and leaks reduced to a minimum.

The condenser should then be studied to determine its best performance at the various loads, and these results checked against those guaranteed by the manufacturer under similar conditions, particularly those of the injection-water temperature and the steam flow into the condenser. Allowance must be made in any apparent discrepancy between the actual steam rate of the unit and that guaranteed for it, due to abnormal

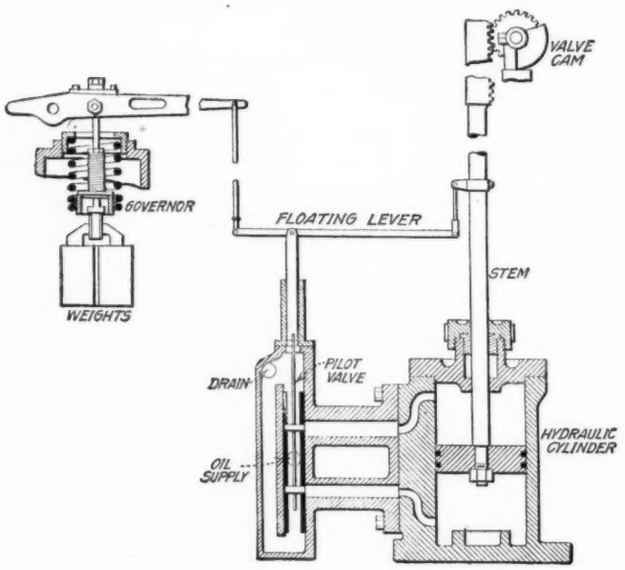


FIG. 9. VALVE-CONTROL MECHANISM

contributing conditions, such as vacuum, steam temperature, steam pressure; since all these values were carefully kept standard during the factory tests.

(The next article will discuss the procedure followed in putting an alternating-current generator on the bus for the first time.)

Removal of Soot From Chimneys

By D. M. Riff
American Steam Conveyor Corporation

It has often times been called to the attention of engineers and plant operators that the accumulation of soot in the bottom of the chimney is detrimental owing to the smoldering fire that frequently occurs and is even a constant menace because of the danger of explosion.

A simple and inexpensive device has been in use for a long time in many plants for keeping the bottom of the stack clean. It is a steam-jet conveyor of small diameter installed with the suction line under the bottom of the stack and the discharge line into the ash bin or pit. The illustration indicates a typical arrangement.

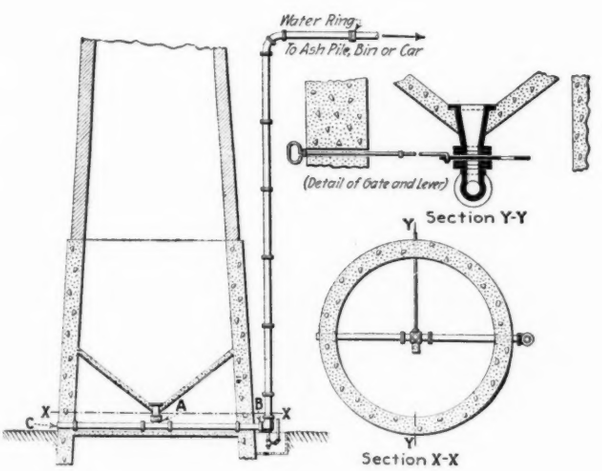
A hopper bottom is built in the existing stack with an opening in the bottom, under which is placed a specially designed intake tee fitting *A*, with a machined box and slide, air-tight gate. This gate is operated by a rod and lever from the outside of the stack wall. The intake tee, of course, is part of the conveyor line proper, which rises at *B* to sufficient height to discharge into the ash bin or pit, over a slope into a valley, or, through a properly designed target box into a cart or wagon.

At the foot of the riser *B* is inserted a steam unit fitting consisting of a body and an end and back cover plate, provided with renewable wear liners which may be replaced by removing the back cover. The bottom cover is drilled and tapped for a nozzle holder and nozzle. The upper bend consists of long-radius type elbows to prevent the possible packing or clogging of the fine flaky soot after it comes in contact with the steam. In the discharge line is placed a properly designed water-spray ring to allay the dust at the discharge end. The air supply is provided through the inlet at *C*.

The operation of the equipment is simple and practically automatic. The valve is turned on in the steam line leading to the nozzle, and in the water line leading to the spray. The expansion of the steam as it rushes through the nozzle creates a suction in the horizontal line. The operator opens the slide gate by means of the outside lever, and the soot flows by gravity into the intake opening. It is conveyed by suction to the point *B* and from there is discharged by the steam through the riser and horizontal discharge line.

Inspection door or peek holes above the hopper are unnecessary because the conveyor operates by sound. When the steam is turned on and the conveyor is running empty, there is a roaring noise as the air rushes into the inlet *C*. As soon as the gate at *A* is opened and the material begins to flow into the conveyor, the sound dies out and does not reappear again until the bottom of the stack is empty. When the roar begins again, the operator closes the gate and then turns off the steam and water valves.

The usual steam-jet conveyor used for disposal of ashes and cinders will not work successfully in removing the soot from the stack base. The soot, compared to ashes, is very fine and flaky, without any real body or surface. A very much higher velocity of the air is



ARRANGEMENT OF CHIMNEY SOOT REMOVAL SYSTEM

therefore required to move this material. This higher velocity is practically impossible in the large-diameter pipes used for handling ashes and clinkers.

These conveyors have been in operation for a number of years in large power plants and central stations. They have also been further adapted for the removal of combustion ashes from the back passes of boilers, and of soot from breachings, flues and economizers.

Induction-Type Overload Relays—Their Operation and Application

By VICTOR H. TODD

Discusses the construction and operation of an overload relay, in which a movement similar to a watt-hour meter is used to obtain a protective device of high accuracy. Transfer relays are also considered.

WHEN the great possibilities of adequate protection were seen, and when it was realized that to obtain this protection a more accurate relay than the plunger type was required, the induction-type watt-hour meter was looked to as a solution of the problem. The voltage winding of the watt-hour meter was displaced by a current winding, and contacts were arranged to close when the current reached a certain value. The torque, or turning effort, of the disk was opposed by a spiral spring. The magnetic and electric circuits of a relay of the induction type are shown in Fig. 3. *A* is the main winding, and under this is another winding similar to the secondary of a transformer, which supplies the polepiece windings *B* and *D*. The path of the magnet flux is indicated by the dotted lines.

Fig. 1 shows a standard induction-type relay and Fig. 7 a schematic diagram of parts as viewed from the top. The disk *A* is mounted on the shaft *B*, is actuated by the electromagnets *C* and is damped by the permanent magnets *D*, in a manner similar to a watt-hour meter, except that both windings on the electromagnet

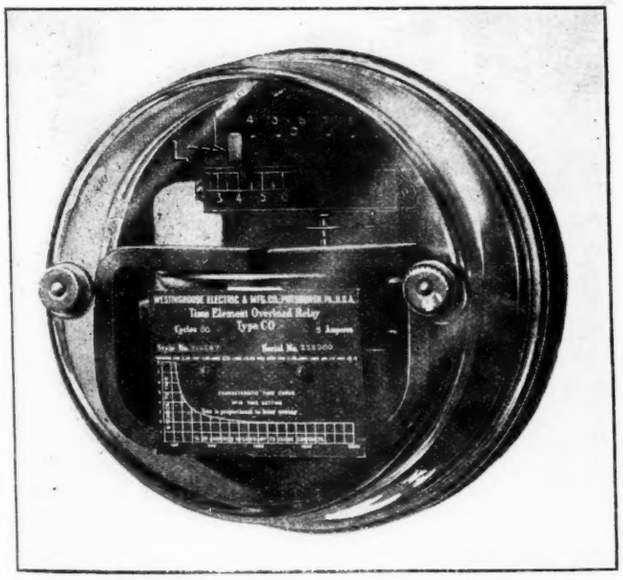


FIG. 1. WESTINGHOUSE INDUCTION-TYPE OVERLOAD RELAY

C operate from the current of the line alone, as in an ammeter. Instead of the disk revolving continuously when current is applied, the rotation is opposed by the spiral spring *I* fastened with its outer end to the permanent support *E* and its inner end to the shaft, which also carries the moving contact *F*. When sufficient current flows through the electromagnet *C* to develop in the disk the necessary torque, it rotates until the contact *F* touches contact *G*, thereby completing the trip circuit.

The foregoing describes the induction-type relay without its present refinements. It had great accuracy,

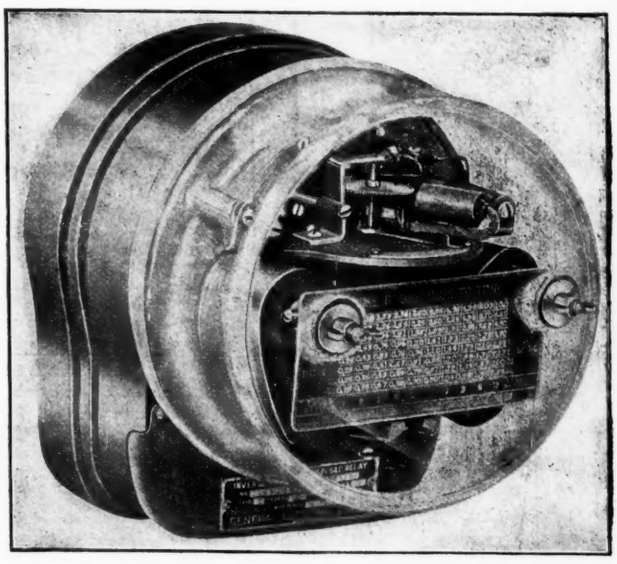


FIG. 2. GENERAL ELECTRIC INDUCTION-TYPE OVERLOAD RELAY

but one great drawback was that the moving contact "floated." That is, the load might be sufficient to turn the disk half way around, so if the relay was set to operate on 5 amperes, and the load was 4.5 amperes for some time and then suddenly increased, the closing of the contacts would be almost instantaneous, because 4.5 amperes caused the contacts to "float" near to the tripping point. To overcome this, several holes were cut in the disk, beneath the poles of the electromagnets. These holes decreased the torque considerably, but once the current became high enough to move the disk slightly, the holes were moved out from under the poles, and the latter then acting on the solid metal, caused the disk to revolve until the contacts were closed. This insured an inverse time limit on all overloads, as the disk was always at its starting point until an overload occurred. As all circuits could not be set to trip on the same overload, taps were brought out on the current coil, which enabled the operating current to be varied over a wide range, a common range being 4, 5, 6, 7 and 8 amperes.

In the induction-type relay, Fig. 1, the taps are changed by inserting a screw in a marked plate, Fig. 4, to make contact with the desired tap. The metal piece *D* has five tapped holes to receive the screw *B*, which may be put in any hole and make contact with the taps *C*. *A* is the main coil wound on the electromagnet and has the taps *C* brought out at the correct

turns to give the desired operation. The block *E* is of insulating material and is arranged so the taps cannot pull out.

As has been pointed out previously, it is sometimes desirable to have an inverse-time limit on moderate overloads and a definite-time limit in the case of severe short-circuits. This combination of inverse time on moderate overload, gradually decreasing to a definite time on heavy overloads or short-circuits, is met in the induction-type relay by the use of a small transformer called a "torque compensator."

This torque compensator is introduced into the secondary circuit as shown in Fig. 6. The main winding

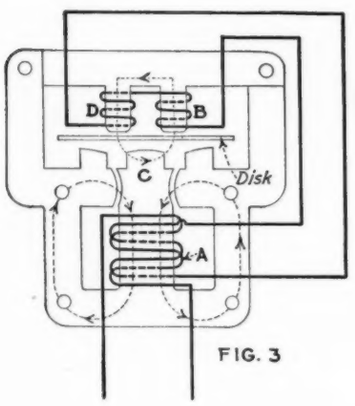


FIG. 3

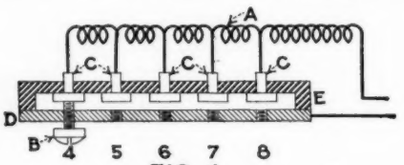


FIG. 4

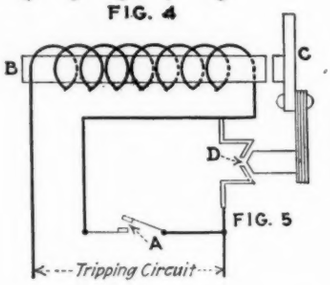


FIG. 5

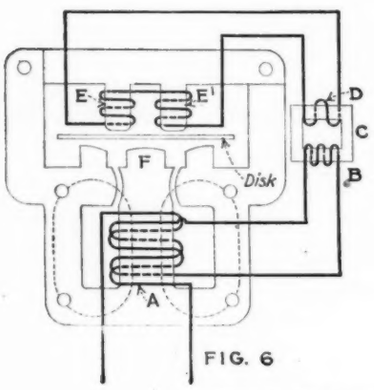


FIG. 6

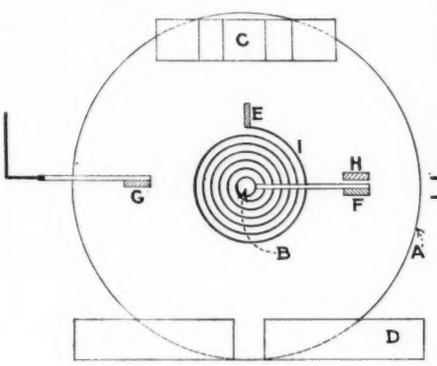


FIG. 7

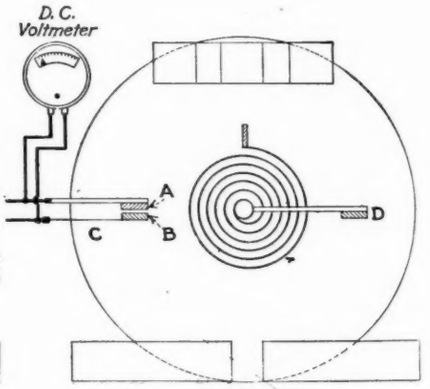


FIG. 8

FIGS. 3 TO 8. DIAGRAMS OF INDUCTION-TYPE RELAY CIRCUITS AND PARTS

stop *H*, Fig. 7, is arranged so that the contact need make only one-fourth revolution, the time may be halved. Other positions, easily set by the lever *L* shown in Fig. 1, enable any time from instantaneous to a maximum to be readily set.

A typical curve for an overload induction relay is given in Fig. 9, reference to which will show that 150 per cent. load takes about 10 sec. for the relay to close its contact, 200 per cent. load requires about 5 sec.; 500 per cent., 2.75 sec.; 1000 per cent. and any overload in excess of this takes a definite time of about 2 seconds. These values are taken at the highest time setting; if the setting is halved, the time is halved. In other words, the time is almost proportional to the lever settings.

In the induction-type relay shown in Fig. 2 the principle of operation is the same as that in Fig. 1. The various current settings are obtained by the use of a small plug, instead of a screw, which makes contact with the various taps. The markings on the time-lever scale are arbitrary, but as will be seen from the figure, any chosen time may be set by reference to the table on the front of the relay.

The contacts of overload relays, necessarily being small, due to the high accuracy required are not designed to open the trip circuit once it is established.

Take, for instance, a circuit-breaker that requires 0.2 of a second to open after the trip coil has been energized. Suppose the relay should make contact, but before the breaker could open, the short cleared itself. Then the relay, instantly attempting to reset, would open the contacts and produce an arc. To prevent this, as well as to transform a light contact into a positive one, a separate contactor switch is used, as shown in Fig. 5.

The main relay contacts *A*, when they close the tripping circuit of the relay, energize a small coil *B* that attracts an iron armature *C* and closes the contacts *D*, which are in parallel with the main contacts *A*. Thus it will readily be seen that even though the contacts *A* should open, the current will pass through *C* and contacts *D* will stay closed until the breaker opens the circuit. Then the coil *B* will lose its pull and open contacts *D*. When a very large breaker is to be opened,

A carries the main current as in Fig. 3 and, by its transformer action, induces a current in the primary *B* of the small transformer. On the opposite side of the core *C* is the secondary *D* which supplies the polepieces *E* and *E'* with the necessary current to react on the main flux, or magnetism, from the pole *F* produced by coil *A*. At moderate loads the current in *D* will increase in proportion to *B*, but the iron in *C* is of a cross-section such that, after the current in coil *B* passes a certain value, the core becomes saturated, consequently the current in *D* cannot increase no matter what the overload may be. Since the current in the coil cannot increase above a definite value, the torque on the disk is limited, which results in a definite time on heavy overloads.

It is essential in the protection of radial and ring systems that the time of the relay be variable. To accomplish this, the angle through which the contact must travel is varied. Thus, if the contact must travel one-half revolution, it may take two seconds, but if a

it is sometimes necessary to install a relay switch, but this is an unusual condition.

To prevent the spiral spring of the movable element from carrying the tripping current, two contacts are

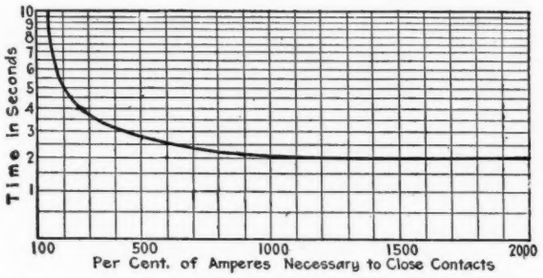


FIG. 9. CHARACTERISTIC CURVE OF INDUCTION-TYPE RELAY

placed near each other, as in Fig. 8. Contact *A* is stationary while *B* is mounted on a thin flexible strip *C*. Then when the disk turns, the arm *D* strikes contact *B*, forcing it against *A*, and completes the tripping circuit.

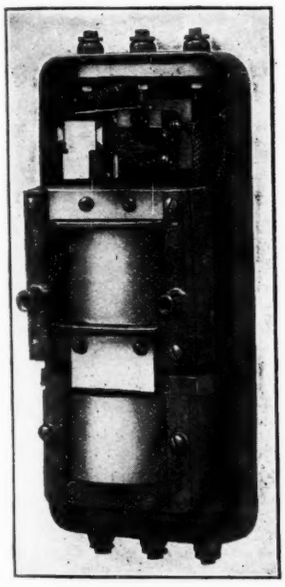
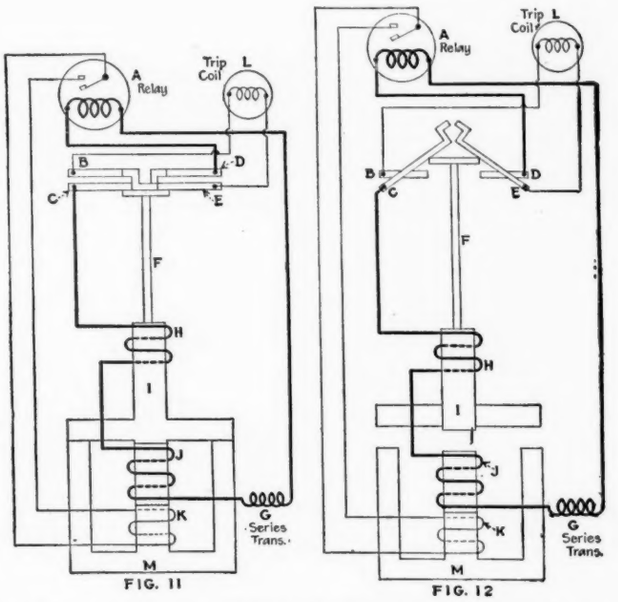


FIG. 10. TRANSFER RELAY

Some companies connect a small voltmeter across the contacts, as in Fig. 8, in order to tell by its continuous indication that the trip circuit is alive up to the contacts. Should the meter fail to indicate, the operator knows immediately that the trip circuit has failed. In other cases a small telegraph relay is connected to ring a bell when the trip circuit becomes dead.

To prevent failure from the foregoing source as well as to apply relays where a direct current is not available, series-trip or circuit-opening relay may be used, but their inherent fault of opening a breaker on slight vibration has discouraged their use. However, by using a "transfer relay," as it is called, the advantage of the series-trip relay may be obtained without its drawback. Fig. 10 shows one of these relays and Figs. 11 and 12 a diagrammatic scheme of parts. *A* is a standard circuit-closing relay of a type similar to those in Figs. 1 and 2. The contacts on the upper end of the shaft *F* are arranged so that *C* makes contact with *D*, while *E* makes contact with *B*, in normal position Fig. 11. When the plunger is pulled up, *C* makes contact with *B* while E makes contact with *D*, Fig. 12. The current from the series transformer *G* passes through the relay *A* and through two coils in the transfer relay. Coil *H* tends to raise the plunger *I*, but coil *J* tends to hold it down, and since the current in both coils is equal, the plunger will not be moved.

Wound on the same core with coil *J* is another coil *K* with its terminals connected to the relay contacts. When the relay contacts close, they short-circuit coil *K*, which has set up in it a current by the transformer acting coil *J*. This current being in opposition to the current in coil *J* tends to demagnetize the core *M* and it loses its attraction for the plunger *I*, allowing coil *H* to pull it up. This changes the switches at the top to the position shown in Fig. 12. It will now be noted



FIGS. 11 AND 12. DIAGRAMS OF TRANSFER RELAY IN NORMAL AND TRIPPING POSITIONS

that the current is flowing through the trip coil *L*, which will trip the breaker.

Fig. 13 shows three single-phase relays protecting a three-phase line in connection with three transfer relays. When the plungers are all down, the trip coil is entirely insulated from the series circuit. If any

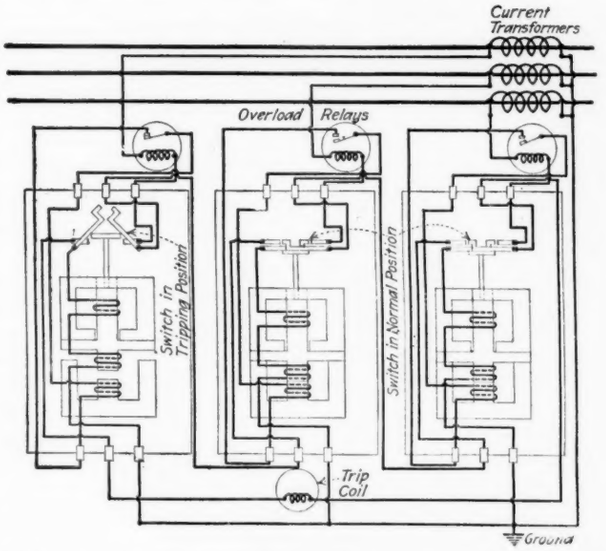


FIG. 13. DIAGRAM OF TRANSFER RELAYS CONNECTED ON THREE-PHASE CIRCUIT

one, two or three relays operate, they will complete a circuit through the trip coil and current transformers under any conditions that may arise. The overload relay *A* gives the necessary accuracy, while the transfer relay gives the advantage of a series-trip or circuit-opening system.

Care of Small Refrigerating Machines

By FREDERICK J. BYRNE

COMMON difficulties occurring in the operation of refrigerating machines, their causes and remedies, are given in tabular form, and are fully explained in the text following the numbered paragraphs.

1. The correct amount of condensing water is about three gallons per minute per ton of refrigerating capacity of the machine with a 9-deg. range of temperature of water flowing to and leaving the condenser.

To determine whether the condenser pressure is too high, reference must be made to an ammonia table giving the properties of saturated ammonia gas. A condensed ammonia table is given here:

It will be noticed that for every temperature of the gas there is a corresponding pressure. Assume that the temperature of the condensing water leaving the condenser is 70 deg. F. The high-pressure gage should show a pressure corresponding to 8 or 10 deg. higher or about 80 deg. F., which is 139.40 lb. If the pressure shown on the gage is higher than this, the causes given in the table should be investigated.

2. If a double-pipe condenser is used, examination of the water pipe, which is the inner pipe, should be made to see that it is not clogged with slime or incrusted with scale. The surface of atmospheric condensers should be examined for the same conditions. Double-pipe condensers should be located in as cool a place as possible.

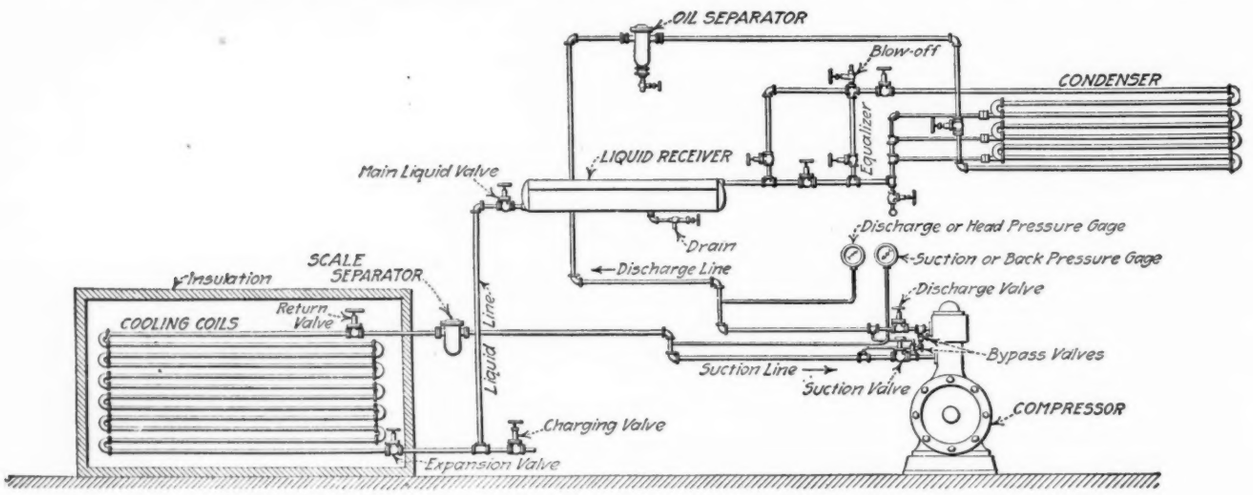
Atmospheric condensers should be placed so that they are protected from the direct rays of the sun and so that they will get the benefit of the prevalent summer winds. The wind will cause some of the condensing water to evaporate and thus cool the rest of the water, with a resultant lowering of the condenser pressure.

In some localities the wind is so strong that it will blow the water off the condenser, resulting in increased pressure. To avoid this and to protect the condenser from the direct rays of the sun, a slatted housing is sometimes built over the condenser, which allows the wind to enter but breaks its force.

3. Before deciding that air or noncondensable gases are present in the system, the operator should be thoroughly satisfied that the excessive pressures are not due to the causes mentioned in one and two of the table, because too frequent purging is one of the greatest sources of high ammonia consumption and waste.

It is customary to purge by having a valved connection at the top of the condensers from which a connection can be run to a pail of water. As long as bubbles can be seen rising noncondensable gases are being discharged. When ammonia starts to blow off the water absorbs it, the bubbles stop and a crackling sound can be heard. The purging valve should be closed immediately when this occurs.

If there is too much refrigerant in the system, the gage-glass on the liquid receiver will show too high a level. The correct level when the plant is in operation and doing its greatest amount of refrigeration should be specified by the manufacturer who installs the machine.



PIPING CONNECTIONS AND APPARATUS IN TYPICAL SMALL REFRIGERATING PLANT

To reduce the amount of refrigerant in the system, a connection should be made from the drain pipe on the liquid receiver to an empty ammonia tank and the liquid allowed to drain out until the proper amount is present. Care should be taken not to fill the ammonia shipping tank too full. Do this by weighing it as the liquid receiver is drained.

4. Reference to the ammonia table and inspection of the gage-glass on the liquid receiver will determine whether this trouble exists. Ammonia should be added through the charging valve of the system, care being taken not to add too much.

5. This condition causes inefficient operation because it results in the gas being superheated instead of saturated. Saturated gas is gas in contact with its liquid, and its volume per pound for a particular pressure corresponds to that given in the ammonia table for that pressure. Superheated gas is gas not in contact with its liquid and occupies a greater volume per pound than that corresponding to its pressure. For example, we see, by reference to the ammonia table, that at 15.67

lb. pressure a cubic foot of vapor weighs 0.1107 lb. or that a pound of ammonia vapor has a volume of 9.028 cu. ft. when saturated. If superheated, it will have a greater volume than this per pound, depending on the amount of superheat. This superheat is due to the difference in temperature between the gas, which is cold, and the rooms through which the suction pipe passes, which are comparatively warm. Because of this difference in temperature the gas is heated, therefore its volume increases. If liquid were present this heat which leaks in would simply supply the latent heat required to evaporate the liquid instead of heating the gas and thus increasing its volume.

With superheated gas, therefore, the compressor pumps a smaller weight of gas per revolution with resultant falling off in capacity.

Under the usual operating temperatures correct conditions will show frost, indicating the presence of liquid, on the suction line just up to the compressor, and the discharge pipe will be fairly hot to the hand.

6. The conditions under 6 of the table cause inefficient operation because they result in liquid returning to the compressor. If liquid is coming back it will evaporate on the suction stroke and prevent gas from being drawn into the compressor, reducing its capacity. Also, liquid coming back will cool the stuffing-box,

TABLE I. AMMONIA COMPRESSOR TROUBLES, THEIR CAUSE AND CORRECTION

	Trouble	Cause	Remedy
1	Too high condensing pressure.	Too little or too warm condensing water.	Supply more or cooler water to condenser.
2	Too high condensing pressure.	Condenser coils fouled with scum or scale.	Scrape condenser coil clean.
3	Very high condensing pressure, trembling of the pressure gage and condenser pipe. Temperature corresponding to the pressure considerably higher than the condensing water discharge temperature.	The presence of air or noncondensable gases in the system or too great a charge of refrigerant.	Blow-off air or noncondensable gases. Take ammonia out of the system.
4	Too low condensing pressure.	Too small a charge of gas.	Add ammonia to the system.
5	Rapid fall of suction pressure. Increase of condenser pressure.	Expansion valve closed or open too little.	Gradually open expansion valve till correct condition is obtained.
6	Too high suction pressure. Discharge connection cold. Heavy frost on compressor.	Expansion valve too wide open.	Gradually close expansion valve till correct condition is obtained.
7	Loud hammering of compressor valve.	Broken spring on compressor valve.	Put in new spring.
8	Irregular action of compressor valves.	Dirty or leaky compressor valves.	Overhaul valves.
9	Capacity of compressor reduced.	Leaky piston.	Overhaul piston and cylinder.
10	Stuffing box and discharge pipe too hot.	Expansion valve closed or open too little.	Open expansion valve wider very slowly.

cause the packing to contract, and leakage of gas will occur. Do not tighten up on the stuffing-box, but close the expansion valve somewhat until liquid stops coming back.

Where the load on a refrigerating machine varies frequently, it is difficult to pack a rod tight because part of the time, when the load it light, liquid may come back, which causes contraction of the packing and leakage. At other times, when the load is heavy, gas comes back superheated, the packing expands and friction is greatly increased because an ammonia stuffing-box is comparatively deep. This friction increases the power consumption and will carbonize the packing.

With a varying refrigerating load as described, if a stuffing-box is tightened when liquid is coming back, it should be slacked off when the suction is dry. Close attention to and regulation of the expansion valve will eliminate a large amount of stuffing-box trouble.

The adjustment of a stuffing-box is a matter of experience with the particular installation to be taken care of.

When the expansion valve is too wide open, the compressor shows too much frost and the discharge line is cold to the touch.

TABLE II. CONDENSED AMMONIA TABLE

Temperature, Deg. F.	Pressure, lb. per Sq.In.	Latent Heat of Evaporation, B.t.u.	Weight of Vapor Lb. per Cu.Ft.
100	200.42	492.01	0.7153
80	139.40	505.05	0.5205
60	92.89	517.93	0.3697
40	58.29	530.63	0.2554
20	33.25	543.15	0.1711
0	15.67	555.5	0.1107
—20	3.75	567.67	0.0690

7, 8 and 9. To make these repairs to valves, etc., it is necessary either to pump out the compressor or to close both the main suction and discharge valve and to allow the ammonia to escape either through the valve provided on some compressors or through an open joint.

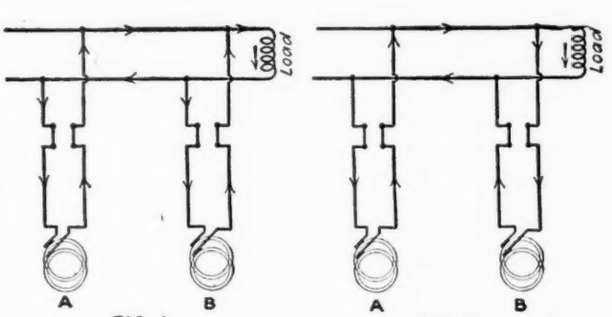
To pump out the compressor, close the main liquid valve and then the suction valve. Run the compressor for a few minutes. Stop it immediately and close the discharge valve tight. The bypass valve on the discharge line should be opened and closed immediately. The valve for the purpose of allowing ammonia to escape from the compressor can now be opened, or if such a valve is not provided, a joint can be slowly loosened. The compressor can now be taken apart for inspection and repairs.

10. See 5.

Hunting of Synchronous Machines

BY ARTHUR HEARVEY

When two alternators are operating properly in parallel, the current flows as in Fig. 1. The voltages are equal and opposite with respect to the closed



FIGS. 1 AND 2. ALTERNATORS CONNECTED IN PARALLEL

circuit of the two armatures and their leads, and therefore there is no current circulating between them. If one of the machines, say *B*, should slow down, the current would flow as shown in Fig. 2. The two voltages are no longer exactly opposing, and a circulating current flows between the two armatures. While this circulating current does not exist continuously, but only during certain parts of the alternation, it is convenient to consider its effect separately. It can be seen from Fig. 2 that this circulating current is in the same direction as the voltage of *A*, and there-

fore acts as an additional load on this machine and causes it to slow down. Since the circulating current is in opposition to the voltage of machine *B*, the load is decreased on this unit, causing it to speed up, and the two machines tend to come together, as in Fig. 1, when they are in step and there is no circulating current. However, owing to the momentum of the swings they will swing beyond the position of no circulating current and a current will flow in the opposite direction. The frequency of this swing is called the natural vibration of the machines. If the machines are direct-connected to engines whose angular velocity is variable, forced oscillations will be impressed on the machines. If the period of oscillation of the engines is within 20 per cent. of the natural frequency of the generators, cumulative swinging will be produced and the machines will be thrown out of step and shut down unless powerful dampers are used.

The magnetic flux in the field or stator produced by the direct-current winding is practically constant in

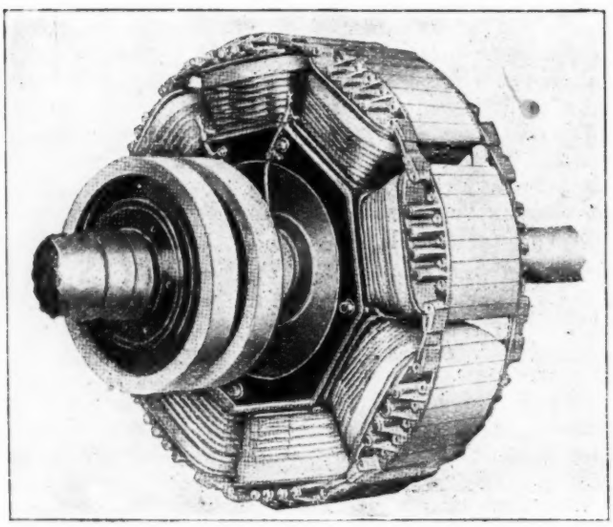


FIG. 3. SHOWS SHORT-CIRCUITED WINDING EMBEDDED IN POLE FACES

value. However, during hunting the flux is driven back and forth across the pole face in time with the hunting. This action does not occur while hunting is not present. The shifting of the magnetic flux is due to a change in the relative positions of the revolving magnetic field of the stator and the geometric center of the direct-current pole. Therefore, if a low-resistance closed-circuit winding is placed around the poles or embedded in the pole-faces, as in Fig. 3, current will be induced in this closed circuit by the shifting of the main field. This induced current, in turn, produces a magnetic field which will prevent or oppose the shifting of the main field, thereby assisting in preventing hunting.

If there is an ammeter in the busbars its reading should be the sum of the readings of the individual ammeters, in which case there is no hunting; but if its reading is less than the sum of the separate meters, the difference is the synchronizing current that is circulating between the alternators and holding them in step.

Atlas Boiler-Tube Cleaner

A tube cleaner for use with return-tubular boilers, which is made to operate with either air or steam, has been developed by the Atlas Manufacturing Co., San Francisco, Calif. It is made for tubes from 2 in. to 6

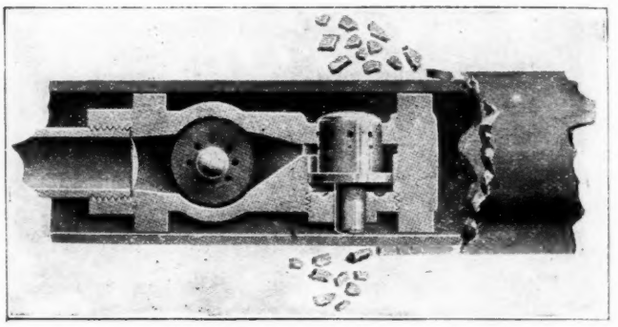


FIG. 1. CLEANER FOR RETURN-TUBULAR BOILERS

in. in diameter. The machine has two plungers operating at right angles to each other, as shown in Fig. 1, and deliveries approximately 10,000 direct taps per minute, the length of the stroke being about three-eighths inch. This rapid tapping causes a constant vibration which cracks and jars loose the scale.

The driving fluid enters the cleaner through the center tube, which is provided with a strainer. With the piston in the position shown, the air or steam enters the small lower ports and escapes through the ports shown at the bottom of the left-hand piston. As the area of the bottom surface of the piston is greater than that around the larger piston head, the piston is forced upward, exposing the upper ports, which permits the air or steam to escape to the outside of the cleaner. When this occurs, the pressure on the upper surface of the piston forces the plunger down, and pressure is again admitted to the under side of the piston and the cycle is repeated.

For cleaning tubes of water-tube boilers a different type of cleaner, Fig. 2, is employed, designed to use

FIG. 2. ROTOR OF CLEANER USED FOR WATER-TUBE BOILERS

either water, air or steam. The rotor is positively driven and has no dead center. It carries a blade that runs longitudinally with the center of the shaft, traveling in a position parallel with the bore of the cylinder. Steam enters at the right, flows through the passages shown at the top and is admitted to the space between the center ring, the rotor and the longitudinal plate at the center. The pressure causes the rotor to revolve, and the water, air or steam escapes through suitable ports to the front of the cleaner and around the cutter head, which is secured to the threaded end of the center shaft.

Boiler-Room Essentials

By H. F. GAUSS

Increasing capacity by installing stokers. Saving effected pays large returns on investment. Use of superheaters and economizers. Simple instrument equipment properly located recommended. Losses from high flue temperatures.

IN THE past it has been characteristic of steam-power plant engineers to pay a great deal of attention to the economy of the prime mover and neglect to a large extent the boiler room. The steam engine and turbine have been brought to a high standard of efficiency, and whatever future improvements may be made, the corresponding gain in efficiency will necessarily be small. On the other hand, the opportunities for saving in the boiler room are large. Boiler efficiencies ranging from 50 to 60 per cent. are common, and the returns possible by installing efficient and labor-saving equipment in the boiler room fully warrant the investment necessary.

Installation of additional equipment in the engine room will sooner or later necessitate more capacity in the boiler room, and unless the latter is already equipped with modern stokers and coal and ash-handling machinery, the logical move is to provide this equipment throughout, instead of adding to the present uneconomical apparatus.

Consider, for example, a boiler room containing six 350-hp. hand-fired boilers, four of which are in constant operation. Tests show that an efficiency of 60 per cent. is maintained and three shifts of two firemen, two coal passers and two ashmen are required. A good grade of egg coal is necessary, and constant attention must be given the fires to maintain even 60 per cent. efficiency.

By installing automatic stokers with coal- and ash-handling machinery, the operating force can be reduced by one-half and an efficiency of 70 per cent. secured, a cheap grade of coal can be burned and a more uniform condition of operation maintained. The comparative cost of operation is given approximately in the accompanying table:

COST OF HAND-FIRING VS. STOKER OPERATION

Old Equipment	
6 firemen at $5 per day	$30.00
6 coal passers at $4.50 per day	27.00
6 ash men at $4.25 per day	25.50
80 tons egg coal at $3	240.00
	$322.50
New Equipment	
3 firemen at $5 per day	$15.00
3 coal passers at $4.50 per day	13.50
3 ash men at $4.25 per day	12.75
79 tons screenings at $2.75	217.25
1 oiler at $5 per day	5.00
	$263.50
Saving per day	$59
Saving per year	$21,535

Assuming an investment in new equipment of $100,000 it follows that:

Interest on investment at 6 per cent	$6,000
Depreciation at 4 per cent	4,000
Upkeep at 2 per cent	2,000
	$12,000

Deducting this $12,000 from the annual saving still leaves $9535, or nearly 10 per cent. above what might be considered a fair return on the money. The gain is more than could be obtained ordinarily on a safe investment.

A typical installation consists of a track hopper into which dump-bottom cars are unloaded. A short cross-conveyor is arranged to carry the coal from the track hopper into a crusher, which in turn discharges the coal into a bucket conveyor. The crusher is provided with a bypass around the rolls and into the main conveyor, to be used in case the coal does not require crushing. The main conveyor is arranged to convey the coal from the crusher and distribute it in overhead bunkers, from which it drops through spouts into the stoker hoppers. The bucket conveyor passes directly in front of the ash doors in the ash tunnel, and the ashes from the various ashpits are hoed directly into it to be conveyed up into the ash burner.

The secret of a successful installation is the providing of ample room for repairing and replacing broken or worn-out parts of the machinery. Permanent platforms and ladders providing easy access to the equipment are indispensable to proper maintenance.

With a uniform load the chain grate with natural draft is a desirable stoker for the bituminous coals mined in the Middle West. Where the load varies and peaks must be met, the chain-grate stoker with forced draft should give better results. One especially favorable feature in connection with the forced draft is that it makes the installation of an economizer possible. With natural draft only, unless an exceptionally high stack is available, the advantage of an economizer is doubtful.

Superheaters are successful when they are located in a sufficiently hot zone of the setting. It is a mistake to assume that a superheater can take the place of an economizer. Sufficient heat head to cause the heat to flow into the steam does not exist in the cooler zones of the setting and breaching generally occupied by the economizer. The proper location for the superheater in horizontally baffled boilers is in the combustion chamber behind the bridge-wall, and not in the comparatively cool last pass or breaching. In vertically baffled boilers, the proper location is at the top of the first pass.

When it is considered that the specific heat of superheated steam is about 0.55, while that of the flue gases is 0.24, and that about 24 lb. of flue gases result per pound of coal burned, it is evident that the amount of heat actually adsorbed by the steam due to its superheat is comparatively small. Thus in a 350-hp. boiler using coal containing 11,500 B.t.u. per lb. and operating at 60-per cent. efficiency, the following results obtain:

Total steam per hour, lb	10,500
B.t.u. absorbed by steam, due to its being superheated 100 deg	577,500
Coal per hour, lb	1,680
Total flue gas per hour, lb	40,320
Reduction in temperature of flue gas, due to heat absorbed by steam, deg. F	59

In comparison with an economizer the superheater, then, does not materially lower the gas temperature, and as often pointed out, the advantage of superheated steam over saturated steam is not due to the additional heat it contains, but to its improved properties.

The efficiency of a boiler and its furnace depends on five fundamental conditions: Proper draft, complete combustion, air-tight settings, clean heating surfaces and low flue temperatures.

In order for these conditions to obtain, the stack must be of the proper size and height, and the breeching must have proper area, be free from sharp bends and as short and direct as possible; the furnace and combustion chamber must be designed and built to suit the particular fuel to be burned; the brickwork or casing enclosing the boiler must be tight, free from cracks and air leaks, and the heating surfaces must be kept free from scale and soot.

The fundamental apparatus necessary to see that these conditions are maintained are: Draft gages connected over the fire and in the breeching, an Orsat apparatus, sufficient soot blowers and tube cleaners and pyrometers. It is the writer's opinion that the simpler the instrument equipment the better will be the results secured by their use.

A separate recording pyrometer in each boiler breeching is desirable. Nothing is more detrimental to economy than high flue temperatures. For instance, consider the 350-hp. boiler used to illustrate in the discussion of the superheated. There were 40,320 lb. of flue gases per hour. An increase of 50 deg. in the temperature of these gases leaving the boiler means that 483,840 B.t.u. are wasted per hour. This is equivalent to 42 lb. of coal, or 2.5 per cent. of the coal fired. In many plants flue temperatures are as much as 150 deg. higher than necessary, which is an avoidable loss of 7.5 per cent. The continuous record given by the recording pyrometer is the best means of keeping check on this source of loss.

In many cases the hand Orsat is more desirable than the CO_2 recorder, when the engineer on watch is required to make gas analyses at least once an hour and is required to see that these analyses show reasonable percentages of CO_2. That is, if he makes an analysis and finds the CO_2 low, he must at once determine the cause, have it corrected and secure the normal analysis. In large plants operating 10 to 20 boilers, this is not practicable and the recording apparatus must be resorted to, with an expert devoting his entire time to the instruments in the boiler room.

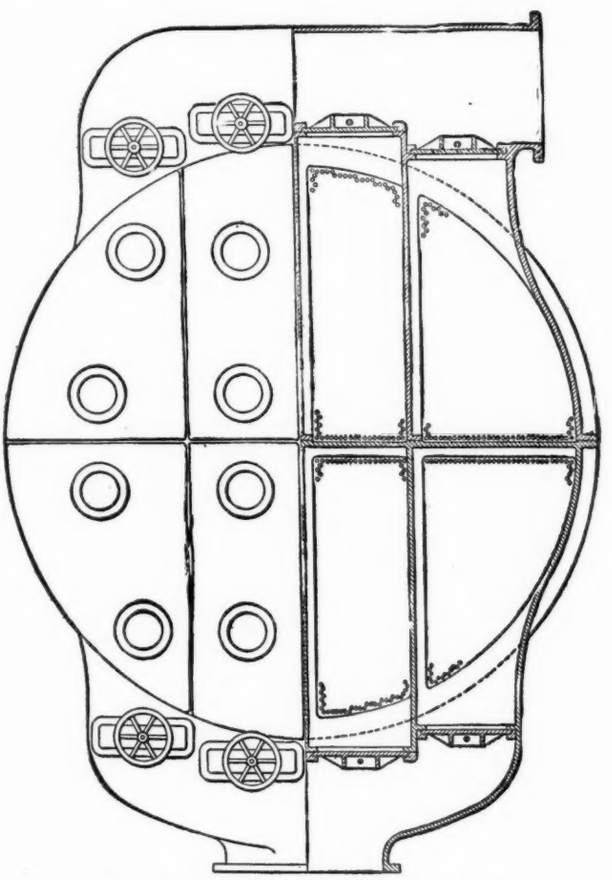
The final evidence of boiler efficiency is, of course, the pounds of water evaporated per pound of coal fired, and no plant is complete that is not provided with a coal scale and feed-water meter. For uniform flow, such as is secured by centrifugal boiler-feed pumps, the venturi meter is the desirable boiler-feed meter. However, with reciprocating pumps some form of "V" notch meter is preferable, as there is some question as to the accuracy of the venturi meter under a pulsating flow. In water-works pumping stations where the feed water is supplied by a number of reciprocating pumps driven by the individual pumping engines, a fairly uniform flow is obtained and the venturi meter has been found satisfactory.

It is desirable that where more than one boiler is needed to carry the load, every unit be operated at least to its rated capacity. It often happens that one or two boilers carry most of the load, while the others are allowed to run light. Indicating steam-flow meters attached to each boiler nozzle are valuable, as they show exactly what each boiler is doing.

In laying out a boiler room it is essential that all gages and controlling apparatus be located in as convenient and accessible places as possible. The damper lever should be brought to the front of the boiler and arranged so that the fireman can keep his eye on the draft gage while regulating the damper. The draft gage, steam flow meter, steam-pressure gage and water columns should all be visible from the same point in front of the boiler.

New Compartment Condenser

A new development in the shape of a compartment steam surface condenser has been made by the Wheeler



SHOWING CONDENSER COMPARTMENTS

Condenser and Engineering Co., Carteret, N. J. It can be cleaned while in service without shutting down the turbine. Any tube or tubes may be temporarily plugged and other repairs made without taking the condenser out of service.

The illustration shows how the condenser is divided into four compartments, each being equipped with a set of valves to control the circulating water. To clean the condenser while the turbine is delivering full power, the operator shuts off the water from one compartment, removes the cover, cleans the tubes, replaces the cover, turns on the water again and then passes on to the next compartment, repeating the operation until the four compartments are clean. Thus, while one compartment is being cleaned, the others are in full operation, temporarily taking over the turbine load.

EDITORIALS

James Watt Memorial

IN THE account of the James Watt Centenary Celebration, appearing in this issue, mention is made of the proposed Watt Memorial. As stated, this is to be in three parts: A research professorship at the University of Birmingham, a memorial building and a memorial volume. The appeal for funds for the chair of research is to be made to the whole world.

This request has a special appeal to the engineering profession on two grounds—first, as a tribute to the man who made modern power engineering a possibility and, second, as a means of continuing the advancement of the industry.

The debt that engineers owe to James Watt can hardly be estimated. Other men used steam before Watt, but he seems to have been the first to apply its expansive force and to condense the steam outside the engine cylinder. It is true his apparatus was crude, in the light of modern practice, but his was the idea. If he had never lived, some other man might have done his work, but the fact remains that he did live and that he did do his work, and how well he did it is evidenced by the fact that one of his engines is still at work.

In giving praise to Watt, no credit should be withheld from the many who have followed and developed his ideas, but credit for the pioneer work must go to him. Many great names live in American history for glorious deeds done for the public welfare, but it was Christopher Columbus who had the vision and the pluck to follow his vision, with the result that a new continent was developed. Likewise, many names will always live in the history of steam-power engineering for contributions to the development of the art, but it was Watt's vision that produced the foundation on which they worked.

From a purely utilitarian standpoint an endowed research department deserves strong support. The art of power engineering has reached what, to many, seems to be a high state of perfection. The demands on the art, however, are increasing even faster than its development. If civilization is to progress, not only must this art continue to progress, but the progress must be speeded up.

The greater the advancement in any line the more difficult it becomes to continue development. The obvious improvements are soon made, and the possible ways of advancement become more and more limited. Progress can be made only by long, hard study. This research cannot be self-supporting. Often years of hard, conscientious work give only negative results. A theory is simply disproved. An idea that promised much is found to be useless. This work does not bring any financial return to the worker, but its importance to the community is often beyond price. A list of "don'ts" is often as valuable as a list of "do's," but the latter are what bring the money.

Many large industrial organizations have research departments that have done wonderful work. Much of the knowledge gained by this work has been freely given to the public, but it is often confined to perfection of existing apparatus rather than the exploration of new fields. What the world needs is more and more "scientific explorers" who are not hampered in the necessity of making their work pay immediately in dollars. Such work can best be done in the endowed research departments in the various technical schools and universities. A large amount of such work is done there, but the field is so large that only the surface has been scratched, and as a rule, the funds are limited. It is in the hope of helping in this necessary work that the promoters of the Watt Memorial have planned to collect funds for an endowment to provide and maintain a school of research "in the fundamental principles underlying the production of power and the study of the conservation of the natural sources of energy."

This appeal, which is made to all the world, should find a favorable response in the United States and especially among the engineers who owe so much to James Watt. Contributions may be sent to the Hon. Secretary, James Watt Centenary Committee, Chamber of Commerce Building, New Street, Birmingham, England.

Why Not a Representative Group?

BROADLY speaking, everybody with very few exceptions, belongs to one of two classes—the employer or the employee. Some belong in both. But regardless of their business affiliations, all have a public interest at stake, and the time has arrived when the great body of safe and sane citizens will see to it that the public dominates. If capital and labor cannot agree, the public will do the deciding and force compliance.

Any decision, however, if it is to have the full backing of public opinion, must be made by a properly constituted and representative body.

When labor bolted the recent Industrial Conference, the public group was requested to continue the work. It made a feeble attempt and then, realizing the futility, gave up the task. But had it possessed the temerity to continue, it is doubtful if the verdict would have been accepted as a basis for procedure in dealings between industry and labor. Not that many of its members weren't of the highest standing and intelligence, but the group was hardly representative of the public. Indeed, it is doubtful if any personally selected group, whether chosen by the President or any other man, could thus be truly representative.

Would it not have been better in appointing such a body to have requested the great national bodies such as the combined engineering societies, the Bar Association, the Chamber of Commerce, etc., each to nominate a man and the group thus formed, supplemented if necessary by a few personal appointees, would have had the backing of all professional and business interests and the respect of labor.

It has been hinted that a second industrial conference may be called. If so, it is hoped that some such procedure will be followed.

Correspondence

Handling Superheaters During the Starting-Up Period

An answer to F. L. Richards's question on "Handling Superheaters During the Starting-Up Period," in the July 29, 1919, issue, page 193, may depend somewhat on the method of installing the apparatus originally. Superheaters are installed in three general ways. First, those provided with a flooding pipe connected with the water space of the boiler and also with a drain line for bleeding the water out of the superheaters. Second, those with only a drain line on the superheater for discharging any water in it, and third, those with no drains.

I have operated the two first-named types but the third—the one without a drain line—I would like to hear full particulars about it from someone who has used it.

The idea of a flooding pipe is to keep the superheater full of water during the starting-up period of the boiler, or at other times when the boiler is not working, should the operator find it desirable. In handling this type of apparatus I have always kept the usual air valve open in the boiler to expel the air while the water was being slowly heated to the atmospheric boiling points. During this period the drain valve on the superheater was kept closed and the valve in the flooding line open so that water was able to circulate freely through the superheater elements.

When steam began to issue from the air valve it was closed and the steam pressure allowed to rise. Just before the boiler was ready to be cut in service the valve in the flooding line was closed and the superheater drain valve opened wide, so that all water could be blown out of the superheater. This drain valve was then partly closed, some steam being allowed to blow through to prevent burning the superheater tubes. Then, after cutting the boiler in service, the drain valve was closed tight.

In handling superheaters with only a drain valve I always close the air valve on the boiler when starting up and open the superheater drain valve wide, until the boiler starts to steam. Then I choke off the drain valve while the steam pressure is rising until after the boiler is cut in service, when it may be closed tight.

If a boiler is warmed up slowly until it begins to steam and this steam is allowed to blow through the superheater and out of the superheater drain line, I see very little advantage in having the flooding arrangement; as steam circulating through the superheater and out of the drain will prevent any burn-outs. The only advantage of the flooding pipe is that it protects the superheater from overheating up to the time the boiler starts to steam. After this point is reached, circulation of the steam through the superheater and out through the drain is just as effective. If an engineer handles a superheater this way he will have no trouble with burn-outs.

A point not exactly in line with the question under discussion is the superheater safety valves. These are supposed to be set to blow off at a lower pressure than the main safety valves, to protect the superheater from burn-outs in case the load suddenly drops and no steam is taken from the boiler, especially when there is a very hot fire in the furnace. Yet some engineers will use extreme care during the starting up period to prevent burn-outs of their superheaters and take a bigger chance by setting down on the superheater safety valve so that it never blows.

WARREN D. LEWIS.

New York, N. Y.

In the plant where I am employed are boilers carrying 200 lb. pressure with 100 deg. F. superheat. Some time ago one of the boilers was down for cleaning and was then turned over to the operating crew.

In our plant each superheater is equipped with a pop safety valve besides the ones on the boiler proper and has a ½-in. bleeder pipe discharging to the atmosphere. When a boiler drops out of line or when the automatic valve on top closes (and this occurs when the boiler stops steaming) the bleeder valve on the superheater should be cracked so that steam can circulate through the superheater.

The crew that was operating the boiler when it was cooled off neglected to open the bleeder, and the crew that started to fill the boiler with water also failed to open it and neglected to watch the gage-glass and shut off the water. As a result, the boiler filled and the water pressure under the automatic valve raised it from its seat, and as the stop valve at the header leaked, the line to the boiler was under pressure. When the water got into the steam line running into the superheater, there was a water-hammer that ruptured the fitting holding the superheater pop valve.

A good rule to follow when firing up a boiler is to see that the superheater bleeder is open and allow it to blow until the boiler is on the line and generating steam with the others.

W. B. CASE.

Baltimore, Md.

Regarding the question of handling superheaters during starting-up period. I have had considerable experience with both stationary and marine superheaters and in my judgment it depends altogether on the type of superheater as to whether it should be flooded or not.

One type I have operated was constructed with plain tubes, and it was just as necessary to have water in the tubes as it was to have water in the boilers, and for the same reason. This superheater was supplied with special valves and connections for flooding the tubes during the starting-up period and during any period that the boiler was cut off from the steam line. The superheater was also provided with drain valves to drain the tubes before cutting the boiler in on the steam line.

Vancouver, B. C., Canada.

ARTHUR REID.

Maximum Length of Longitudinal Boiler Seams

In *Power* of Aug. 12 editorial notice is taken of some notes of mine appearing in the same issue under the caption of "Physical Tests of Boiler Steel Plates" and particularly my passing reference to certain experiences of the British Columbia Inspection Board in regard to maltreatment of steel plates used in a series of logging-engine boilers. Inasmuch as these boilers featured the continuous longitudinal lap seam (there were two seams, one on each side) it is suggested that their behavior has a bearing on the discussion now going on in *Power*.

To begin with, I may say that the seams of these vertical logging boilers measured 9 ft., which was the whole length of the shell, and beyond the fact, disclosed by one destructive explosion, that grooving under the lap was deepest midway between the plane of the furnace crown and the top of the shell, there was no allusion in the course of the subsequent inquiry by the inspection board to any influence the continuous seams might have exerted. It was obvious, of course, that the grooving had been hindered in its progress by the proximity of the furnace stays at the lower end and by the top head at the other.

The stresses set up in a boiler shell are most complex in character, being combinations of tension, compression and shear, and notwithstanding all the labors of mathematicians it is still a fact that this branch of knowledge (that is, the resistance to combined stresses —for instance, the case of combined bending and torsion, the combined hoop and longitudinal stress) is still experimentally imperfect. Then, as Dr. Urwin remarked lately, the fact that material is always calculated on its resistance to tension, whereas its real criterion of safety is its resistance to shear, inserts another disconcerting factor.

It appears that in the case of a boiler shell the great difficulty is to determine precisely where and how the actual stresses occur in the structure. For example, consider the case of a spherical boiler head. Here theory proves the strees to be only half that in the shell, from which it might be concluded that the material of the head need be only one-half the thickness of the shell. But then there is such a stress as drum tension known to be present, which constitutes an unknown factor of the elusive kind unloved by the designer. The result is that the spherical head is made the same thickness as the shell and very often $\frac{1}{16}$ in. thicker, thus exemplifying the good old engineering maxim that "The engineer is always greater than his formulas."

I am in full agreement with the view of Mr. Huston of the Lukens Steel Corporation. A riveted seam cannot be stronger than the solid plate. C. E. Stromeyer, in his "Marine Boiler Construction," deals with this question quite directly in the chapter on mechanics. "If the boiler shell is built up of several strakes and the longitudinal seams break joint it has been argued that the stresses are proportionately reduced, and that they should be calculated as follows:

$$S = \frac{pDL}{2t\Sigma(\Delta l)}$$

where P = pressure, S = stress, D = diameter in inches, L = length in inches, T = thickness of plate, $\Sigma(\Delta l)$ = the sum of the widths of the plates, including the flanged end plates, from which the rivet holes of only one longitudinal seam have been subtracted. As $\Sigma(\Delta l)$ is often greater than L, this view would lead to the conclusion that a riveted shell is stronger than a solid one. Clearly, this argument is true only as regards the mean stresses, and that it leads to valueless results is proved by the fact that the same reasoning applied to a beam would lead to a wrong conclusion, for its mean stress is just nothing, being $+ S$ at the top and $- S$ at the bottom."

The ordinary formula is the well-known $S = PD \div 2t$.

Mr. Stromeyer in the same chapter shows that the incidence of a circumferential seam in a boiler shell actually set up several stresses along a line in the solid plates that is a continuation of the central line of the joint. This he modestly figures at four times as much, although certain experiments showed the stress to be eight times greater than in the joint itself, a condition of things that could be remedied only by making the joint exactly as elastic as the plate, a considerable tax, surely, on the boilermakers' art!

In all he says about the iniquities of the lap seam of whatever length, I am in agreement with the chief inspector of the Hartford company, only I would go farther and rule it out of existence. That the shortness of the seam does not make it immune from grooving below the lap I have had proved and with a personal drenching to boot—a logging boiler again, but with circumferential seam breaking joints. The seam burst open for a distance of 20 in. from the top while undergoing the hydrostatic test. There was a heavy stay-rod bracket riveted to the shell near the seam, which by interfering with the resilience of the latter no doubt contributed to defects inherent to the lap-seam principle itself. In this case there was no question of "grain" and, as I have said, there was a circumferential seam located presumably at the right place. Yet it failed, and I am glad of the opportunity to put the fact on record if it may serve as a letter in a word of the epitaph that is slowly being composed for the longitudinal lap seam.

Quite properly I should, with some diffidence, take issue with Mr. Jeter on this question of circumferential seam as a stiffening feature in a boiler shell if the word stiffening be used as synonymous with strengthening. This admirable insurance system of which he is chief inspector has the experience of half a century to draw upon, experience varied as it is authoritative. I think, however, that the quoted argument of Mr. Stromeyer is very convincing. It is supported, too, by the new code recently compiled by the British Marine Engineering Design and Construction Committee presided over by A. E. Seaton, an engineer of international repute. In regard to boilers it reads: "It is desirable that double-ended boilers should be made with not more than three drums or strakes, the circumferential seams being as far removed from the middle length as possible." The wording here is rather ambiguous, still the meaning clearly is that the middle strake should be as wide as possible.

The photograph accompanying Mr. Jeter's article seems to indicate that the ammonia-retort shell had been held firmly by the roundabout seams while the plates intervening bulged to a very decided extent. It would be difficult, however, to conceive of the same vessel taking upon itself such grotesque features had it been subjected to internal pressure alone.

I have seen a return-tubular boiler among the remains of a sawmill—a sawmill provides an excellent fire test—with a hump on the shell close up to the circumferential seam, deforming the latter to the extent of permanently putting the boiler, solely on that account, out of commission. Speaking of a hollow cylinder, or any metallic structure for that matter, as having passed through a fire and making deductions, other than its fuse point, from its appearance is rather risky from a logical standpoint. With a prepared subject and a fire completely under control valuable information might be gleaned and an interesting experiment carried out, but with the ordinary accident fire and its attendant hose practice, it is hard to say into what capricious forms things may shape themselves.

The length of a longitudinal seam in any type of boiler need be limited only by the facilities the steel maker has for rolling sound, wide plates. No kind of longitudinal joint should be in direct contact with the fire. An empirical formula for the injurious effects accruing from any such construction might well read as varying directly as the 1 + nth power of the sum of the thicknesses of the plates compressing the joint. Contact with the fire of a clean plate, the conductivity of which is not overtaxed, does not influence appreciably the stresses on the longitudinal seam.

All that I have said in the foregoing is arguable. Engineers as a class are proverbially tenacious of an idea and rarely let go a rooted opinion without keen disputation. So it is with the men who make rules and codes governing engineering practice. They, also, are but human. I am not at all sanguine, therefore, as to this discussion clearing the air for a uniform boiler standard; the more pronounced result will rather be a reaffirmation of how doctors will continue to differ. Authorities might be quoted for and against the restrictions of the rules and the presumed modernness of the code, thus fully exemplifying the adage that even "The devil can quote Scripture for his purpose."

An editorial in *Power* of July 1, 1919, says the discrepancy is neither political nor geographical. Perhaps it is to a greater extent sentimental than anything else. An ancient community like Massachusetts, in which boilers were built at a time when these Western parts knew only the Red man, changes its practice only after due deliberation and when a certain mild prejudice in favor of its own mosaics has been overcome. There is no doubt that some of the boiler restrictions there have outlived their time and are now more conventions than an unbiased appreciation of the changed conditions. The omission of water-tube boiler mention is significant of the archaic because there is no good reason for discrimination under the otherwise general ban.

The progressed spirits at Seattle have gone, years ago, ahead of the lap-seam strictures of the A. S. M. E. Code by eliminating it altogether. A new lap-seam boiler cannot be installed in that city, neither can one be moved from its setting save to the scrap heap—or another town.

So that Seattle is surely in advance of the good Puritans of Massachusetts as well as the Academic American Society of Mechanical Engineers. That Seattle is not very far from Vancouver, B. C., may be quite another matter entirely. FREDERICK BIGGAM.

Office of Inspector of Steam Boilers.

Vancouver, B. C.

Smokeless Chimney Not Conclusive Proof of Furnace Economy

I appreciate the fact that the majority of *Power* readers are not of the type of engineers who gain their information solely by means of the monkey wrench, screwdriver and steam gage, and through mouth-to-mouth confabs, but in the issue of Sept. 2, page 401, under "Inquiries of General Interest", there is a title the "Smokeless Chimney Not Conclusive Proof of Furnace Economy."

This is not the first time that I have seen such a statement published in industrial papers and probably in the same manner, but frequently the reader and sometimes the inquirer go no farther than the title and is convinced that the body of the answer confirms the statement and believe that a smoking chimney is just the thing.

Is it not true that a smokeless chimney is tending in the right direction? Are not the vast majority of smokeless stacks indications of economically operated boiler plants? On the other hand, is a smoking stack an indication of anything but waste and inefficiency? Why limit it to boiler plants? Take any sort of stack from the common cook stove or heating stove or even fireplace if you will, up through the whole array of furnaces to the very flexible multiple-retort stoker with its great possibilities as to capacity; and other things being equal, if your reader was contemplating purchasing a plant, judging from the top of the stack and making his deductions from the mentioned article, he would probably give preference to the one making smoke and perhaps he would want it to be good dense black smoke in order to be perfectly sure that he would not be troubled with excess air.

The plant that is troubled with more than 100 per cent. excess air is usually the one ready for the scrap heap that gets its air at some other place than through the furnace, and it is the exception rather than the rule. This conclusion is arrived at after many years' experience in the combustion game in the Pittsburgh territory with its 57 varieties of furnaces.

In the most recent and up-to-date power-plant practice, with furnaces operating at the highest efficiencies possible its capabilities are limited only by the amount of air that can be properly supplied through the fuel bed.

If I were going to gamble on economical plants, I would put my bet on the clean stack every time. In this district the owners and operators are always ready to apologize for a smoking stack as a sign of waste; still we have some such stacks, but the inefficient, like the poor, are always with us.

This is not intended to criticize what was said, but the way it was said, for the writer is convinced that the policy of *Power* is for clean stacks.

Pittsburgh, Penn. W. E. PORTER,
Chief, Bureau of Smoke Regulation.

[We agree with the statement of our correspondent that the highest efficiency may be unattended by smoke, but on the other hand, there may be low efficiency when there is no smoke and therefore the title "Smokeless Chimney Not Conclusive Proof of Furnace Economy" correctly expresses that simply absence of smoke does not necessarily indicate that all other conditions for best economy are present.—Editor].

Resistance in Series in Parallel

It often becomes necessary to connect switches or other current-controlling devices in a circuit where time is essential in changing from series to parallel in order to bring about certain results. This is especially true where the apparatus used is exposed to heavy overloads and the time of their duration must necessarily be limited. Even simple arrangements

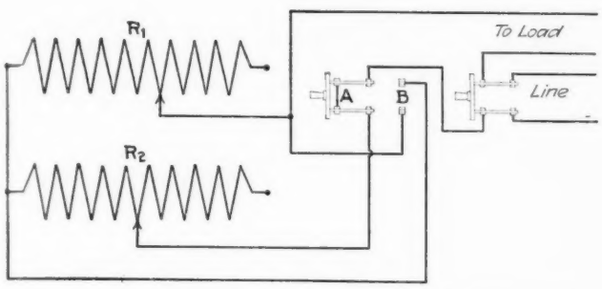


DIAGRAM OF SWITCHING SCHEME FOR CONNECTING TWO RESISTANCES IN SERIES OR PARALLEL

of connections and apparatus sometime require not a little time and effort before the solution is found.

I once had occasion to assist in the making of a large number of tests where the time element of current duration had to be as short as possible to prevent the burning out of some of the testing apparatus. The arrangement shown in the figure was used for connecting two resistances in the circuit from series to parallel, by means of a double-pole, double-throw knife switch. When the switch is thrown to position *A*, the resistance R_1 and R_2 are connected in series, and when thrown to position *B* they are in parallel.

Greenville, Penn. C. R. BEHRINGER.

Cooling Clinkers in Boiler Rooms

In boiler rooms where there is but one fireman without an assistant the problem arises as to how the clinkers may be cooled as they are drawn from the furnaces so as to lessen the excessive heat. We have overcome this by the following method: We placed a sprinkler six inches in diameter, with a stop-cock just above each fire-door. A half-inch water-supply pipe with ten pounds pressure was placed across the front of the boilers just above the fire-door frames.

With this arrangement the man cleaning the fires can coal the ashes as fast as they are drawn, thus lessening the heat to a great extent and keeping the dust down. THOMAS J. PASCOE.

Norway, Mich.

Gas-Engine Piston Rings

On taking charge of a large gas-engined power plant, I was surprised to find that a set of piston rings lasted but six weeks in one of the engines, and I was informed that it was the usual life of a set of rings in that engine.

The next time the engine required new rings, an examination revealed that the cylinders were badly worn on the bottom and that there was a shoulder at each end of the ring travel such that no self-respecting piston ring could be expected to jump up and down on about one hundred and fifty times each minute for days at a time without breaking.

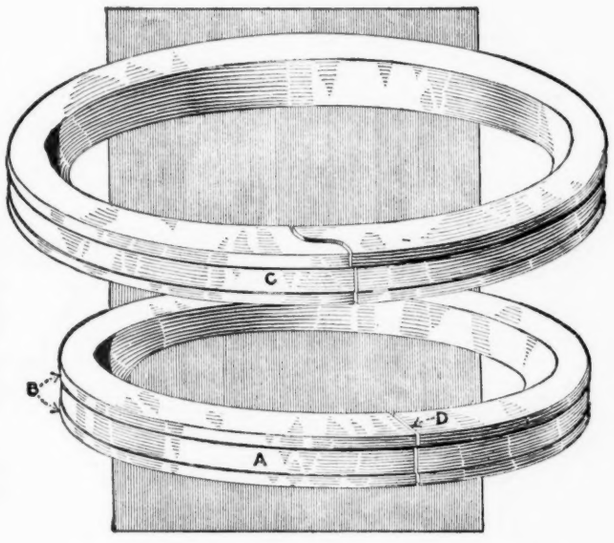
It was the practice to have a spare piston and rings all ready to put in the engine upon taking the old one out, and as there was some little difference in the way that the thread was started on the end of the rods, and as the rod had to be set with a certain connection at the top, it was hardly possible to get the clearance divided so that the ring travel would be the same with each piston; consequently, the ring would travel the shoulder at one end or the other of the stroke.

The shoulders were chipped out flush with the bottom of the cylinders, and the intermediate and tailrod crosshead shoes shimmed up until the pistons did not drag on the bottom of the cylinders.

The pistons carried three wide rings, which were discarded and two narrow rings placed in each groove. These changes made it possible to get from a set of rings six months' run instead of six weeks. The practice of placing the two rings in each groove was continued as long as the old pistons were good, but when new pistons were required, they were made with five narrow grooves instead of the three wide ones.

I have known pistons so equipped to run for two years, but it was in smooth straight cylinders, that were badly worn, as were those on the engine in this case.

The rings were also undercut about 1-64 in. for almost the entire width, as shown at *A*. The narrow edges *B* would wear away quickly, allowing the ring to fit itself to the cylinder and the piston to get down to



UNDERCUT PISTON RINGS AND JOINTS USED

business in a much shorter time than if the whole width of the ring had to wear to a fit.

The ends of the rings were originally cut to make a lap joint, as shown at *C*, but as the points would break off, the joint was changed to a square butt joint, as shown at *D*, and each ring fitted into the cylinder so that there was about $\frac{3}{32}$ in. clearance between the ends at the smallest cylinder diameter.

Cherryvale, Kan. EARL PAGETT.

Watt Centenary Celebration in England

By I. WILLIAM CHUBB

WHILE the early ties between James Watt and Greenock and Glasgow are well known, and even London can make some claims on Watt as a citizen, everyone will admit that, as the major portion of his life-work was done in or near the Birmingham district, it was appropriate that the English Midland area should be the scene of the Watt celebrations and the commemoration of the centenary of his death. The arrangements were made by general and subcommittees of Birmingham engineers, the general committee being under the chairmanship of William Mills, who will at once be connected with hand grenades, R. B. Askquith Ellis being the honorary secretary. Representatives of various universities, colleges, technical and scientific societies and institutions, besides local and other firms and local authorities, also took part in the organization of the celebration.

As a result, direct or indirect, of the war, visitors from abroad were not as numerous as the occasion might have been thought to call for, but France was represented by Monsieur A. Rateau, Sweden by Dr. Carl Benedicks and Japan by Prof. K. Takemura, while from the United States Sandford Riley and the American Ambassador, the Hon. J. W. Davis, took part in the proceedings. Professor Arentz, of Trondhjem, had, owing to an error as to date, paid a visit to England in August, and among the visitors were lineal descendants of Boulton and Watt in the persons of Miss Gertrude Boulton and Major J. M. Gibson-Watt, the British navy being officially represented by Engineer Vice-Admiral Sir G. G. Goodwin.

One effect of inquiries started by the main committee may be the correction of the generally accepted date of the death of Watt. This now seems to have been established as having taken place on Aug. 25 and not Aug. 19.

The proceedings formed an opening move in a campaign to raise funds for an international memorial to commemorate Watt, the funds to be employed as follows: "(1) To endow a professorship of engineering to be known as the James Watt chair, at the University of Birmingham, for the promotion of research in the fundamental principles underlying the production of power, and the study of the conservation of the natural sources of energy. (2) To erect a James Watt Memorial Building, to serve as a museum for collecting together examples of the work of James Watt and his contemporaries, Boulton and Murdoch, illustrating this interesting epoch in the history of engineering. The building would also serve as a meeting place and library for scientific and technical societies, and be a center from which engineers could co-operate in spreading technical knowledge. (3) To publish a memorial volume."

The writer understands that for a chair of research £30,000 to £40,000 will be required, and for the proposed building something like a quarter of a million pounds. As to the chair of research, an appeal to all the world is to be made for funds.

Following the formal inauguration of the commemoration at the Mason's College, Birmingham, by the Lord Mayor of Birmingham, on Sept. 16, an address was delivered by Prof.

FIG. 1. OCKER HILL ENGINE BEFORE ITS REMOVAL FROM SMETHWICK.

F. W. Burstall on the rise of engineering manufacture, in which he ascribed the lack of development through the Middle Ages to lack of power rather than to any other single cause. He mentioned that in Watt's early days a great deal of small, very finely made articles were produced, but the production of large articles was impossible until the steam engine, as improved by Watt, enabled machining to be undertaken. At Soho modern engineering practice has its beginning, but its effect was not apparent in manufacturing until probably about 1870. From that time modern manufacturing, made possible by the steam engine, really developed.

On the same day in the afternoon a full choral service was held in St. Mary's Church, Handsworth, the church which Watt himself attended and where will now be found the Chantrey statue of him, together with busts of Boulton and Murdoch. The address delivered by Canon E. W. Barnes contained a review of the life of Watt, and his genius was ascribed to the combination of imagination, manual dexterity and an inherited ability for mathematics.

Later, in the afternoon at Heathfield Hall, the residence of George Tangye, a garden party was held, and, half a dozen at a time, the visitors had the opportunity of inspecting the oft-described garret workshop, which now, after a lapse of 100 years, is maintained just as when Watt left it. A proposal has been made to remove it bodily to the Watt Memorial Building when this shall come into existence.

In the evening a reception was held by the Lord Mayor of Birmingham in the Council House, and a collection of Watt, Boulton, Murdoch and other relics was displayed in the adjoining Art Galleries. The basis of the exhibition was the Boulton and Watt collection formed by the late W. H. Darlington, for twenty years manager of the Watt firm, and bought by George Tangye. This collection was presented by Mr. Tangye in 1915 to the Birmingham Municipality, and is now normally in the Reference Library, Ratcliffe Place, Birmingham. In addition articles were lent by Miss Gertrude Boulton, by Major J. M. Gibson-Watt and others.

The exhibits included a number of personal relics of Watt himself, lent by Major Gibson-Watt. But the engineer will perhaps turn more readily to the case of drawings actually executed by Watt himself, the first drawing showing the Colville engine of 1776 with steam jacket. The Chelsea Waterworks engine of 1777 is shown with plug rod for expansive working and with a load box over the force pump to cause the outstroke. A Watt drawing shows the Ales and Cakes engine of 1779, but does not include the cylinder covering. Another Watt drawing of 1784 illustrates what is understood to be the first development in that year of the parallel motion, described as "a roller working in slides above the main lever, to which is connected a single link from the crosshead." In another panel a drawing is given of the first sun and planet engine. It was supplied to Goodwyne & Co., London, in 1784.

A set of four agreements relating to sun and planet engine shows that for a 14-hp. engine supplied in 1792 the Boulton and Watt firm would receive £70 a year for 25 years by way of royalty. Then for a 12-hp. engine in Birmingham the annual sum to be paid was £60, and by an agreement of 1796 the firm received £965 for a 16-hp. engine.

As to marine work, a drawing shows the parts of the engine made by the Boulton & Watt firm for Fulton's steamboat, 1804. The boilers were made in America and a detail is given of the valve gear of the engine, while another drawing in the same collection similarly shows steam cylinders, condenser and air pump of another Boulton & Watt engine supplied to Fulton in 1811, together with a preliminary sketch of the engine. Drawings relating to a Glasgow boat, dated 1813, show a pair of engines built with the cylinders inside the boiler, for steam-jacketing purposes. Passing over earlier war vessels, steam packets, etc., we may note the drawings of a 20-hp. dredger for Hamburg in 1845, thought to be the first steam dredger built. Another drawing relates to the "Beaver," of the Hudson Bay Co., reputed to be the first steamer to cross the Pacific.

A manuscript book in Watt's handwriting deals with engines made between 1773 and 1775. An entry dated Dec. 27, 1774, states that "the wood piston being found faulty, a hat piston not oiled was put in. It was first covered with horse muck, but it being found that air pervaded it, it was covered with paper pap mixed with flour paste."

On Sept. 17 the first lecture was by Sir Oliver Lodge, on sources of energy; that is, energy due to the structure of the atom itself. If this can be utilized, he suggested, it should improve social conditions, preventing smoke due to imperfect combustion and dirt due to ashes, while the power is compact and clean; on the other hand, explosions might result from the too rapid liberation of energy.

Following this was a lecture prepared by Prof. A. Barr and Prof. J. D. Cormack, illustrated with lantern slides and descriptive of the work done by Watt with the Glasgow model of the Newcomen engine. In the course of the lecture it was claimed that Watt's inventions were due directly to the knowledge of scientific principles, not merely to chance observation.

In and around Birmingham are several Watt built engines and on the afternoons of Sept. 17 and 18 visits were paid to three of these. The engine now at Ocker Hill, near Tipton, was originally at Smethwick, being built by Boulton & Watt in 1776 for the Birmingham Canal Navigation Co. Consequently, it is the earliest pumping engine in existence built for sale

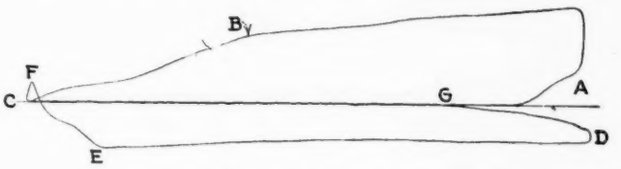


FIG. 2. DIAGRAM FROM OCKER HILL ENGINE.

by the firm. The steam cylinder is 32 in. in diameter with a stroke of 8 ft., though as running at the time of the visit the stroke was, we believe, 6 ft., and the pressure was given as 15 lb. absolute. The water pumped per stroke was 223 gallons. The engine is installed in its own house and is without steam, which was supplied from a launch on the adjoining canal. Running, it made 14 strokes a minute, and indicator diagrams were taken by Prof. F. W. Burstall with an original James Watt indicator. The engine worked regularly until 1892, when it was taken down, removed and re-erected. The chain is usually in tension, but the links are closed somewhat to avoid the effect likely to result from compressive action. The beam bears a pendulum-type counter. It may be mentioned that the 2-in. bolts used for fastening have threads that were cut by chisel and file. The illustration shows this engine in position at Smethwick, where the lift was about 21 ft.

One of the indicator cards taken at the time of the visit is reproduced in Fig. 2. This engine worked only on the downstroke, the upstroke or "out" stroke, as it was sometimes called, being accomplished by the weight of the pump rods and plungers. At the beginning of the working stroke, steam was admitted above the piston while the bottom of the cylinder was connected to the condenser. When the stroke was partly finished, cutoff occurred and the steam worked by expansion. Later, the exhaust valve was closed, and at the end of the stroke an "equilibrium" valve connecting the two ends of the cylinder was opened. This equalized the pressure above and below the piston and allowed it to rise. Near the end of the upstroke the equilibrium valve closed, giving a cushion or compression in the top of the cylinder, the exhaust valve opened, and at the end of the stroke admission occurred again and the cycle was repeated.

Referring now to the card, the upper portion is taken from the top of the cylinder and the lower portion from the bottom. Admission occurs at *A* and cutoff at *B*, giving expansion from *B* to *C*. At the same time the lower end of the cylinder is exhausting as shown from *D* to *E*. At the latter point the exhaust valve closes and the pressure rises due to compression to *F* when the "equilibrium" valve opens and the pressure equalizes in the two ends. The line from *C* to *G*, which in this card coincides with the atmospheric line, represents the transfer of steam from above to below the piston at constant pressure, while the piston rises. At *G* the exhaust valve opens and the equilibrium valve begins to close. The cards were taken with a 15.4-lb. spring.

Under its original conditions the pump had a lift of 21 ft., while these cards were taken under a lift of only 3 ft. Weights

were hung on the pump end of the beam to give the engine more load. The piston was leaking badly at this time, so that the vacuum shown on the cards was much less than normal.

The engine at Bowyer Street, Bordesley, was built in 1795 and ran regularly until 1884. The steam cylinder is given as 46 in. diameter by 8 ft. stroke and the pump of 32 in. diameter, and drawings giving details of the valve gears were among the collections in the Art Gallery. Two wagon-shaped boilers were originally employed, and the steam pressure was about 2½ lb. that is, the engine was practically atmospheric. In fact, one of the means taken to present boiler leakage was to employ at the joint a stuffing of firewood, knocked in. On top of the engine cylinder head was a depression in which Russian tallow was melted for cylinder-lubrication purposes, and examples of the gasket, links, pins, etc., are collected in the engine house. One feature is that the beam has its center of gravity below the axis of suspension. This engine has been standing since 1884, having been rediscovered by Dr. J. R. Ratcliffe, who acted as guide. It has hardly a new part on it, although subsequent to its first condition the beam has been fitted with a top strut bracket and three chains are attached, whereas the original drawing shows but two. The relics here include an old Watt lathe sent out with the engine for the purpose of effecting repairs, the original James Watt spanners for the nuts on the beam, etc.

The remaining engine, at Lawley Street, Birmingham, has been running since 1819, being used in connection with canal locks. Even now it does, as required, its ten hours a day. The cylinder is 36 in. diameter by 7 ft. stroke, and the pressure 10 lb. or less, the strokes made being 12 per minute, the lift 46 ft. and the power roughly 36 hp. Of the saddleback boilers originally installed, one is at present used to hold rainwater, and the steam is supplied from a Cornish boiler.

On the morning of Sept. 18 a visit was made to the works of W. & T. Avery, Ltd., Soho, who in 1895 took over the place from James Watt & Co. The Soho Foundry was built in 1796 by Boulton & Watt as an extension of the original Soho factory, which was a mile or so distant, and its purpose was to manufacture and finish heavier machinery. James Watt & Co. succeeded Boulton & Watt after the death of James Watt, Jr. Visitors saw the original entrance place, including, too, a clock that has been running since 1812, and a row of houses for work people built in 1796, in one of which Murdoch lived down to 1817. What is often stated to be the original gasometer, the first of its kind, was also shown. Certainly it is the site of the first, although the original drawings, the writer thinks, show a square gasometer, whereas the present is circular. Copper pipes which conveyed the gas to Murdoch's house, almost a mile away, have been found in the course of excavation. Part of the original workshop remains. The engine-erecting shop, in which were built, for example, the engines of the "Great Western" and also the engines for the Fulton steamship, is still employed, though now chiefly occupied with the erection of testing machinery. Some machine tools remain that date from the early ages of mechanical engineering; for instance, a wall planer known to be 120 years old and thought to be the first of its kind. There is also a faceplate lathe that has been running for some 90 years, having been removed from the Soho factory when those works were closed in 1850.

On the same day at noon a degree congregation of the University of Birmingham was held in the Birmingham and Midland Institute, where honorary degrees were conferred on the United States Ambassador, Prof. A. Rateau, Prof. Barr, Sir G. Beilby, F. W. Lanchester, and others.

On Friday, Sept. 19, visits were made to local engineering works, and the final item in the series of functions consisted of a procession in the afternoon of Saturday, Sept. 20, from near the center of the city to the Botanical Gardens, Edgbaston, where a fête was held. In addition to concerts, lectures were delivered on Watt and the significance of his invention. In the procession was a half-sized model made by a number of local engineering firms of the Watt lap engine. Engines and pumps, drilling machines, weighing machines, motor cars and tractors, electrical machinery, etc., were also in the procession, with deputations from the various engineering trade unions, this part of the program having, in fact, been organized by trade unionists themselves.

Electricity Supply in England During the War

A paper on "Electricity Supply During the War," by A. B. Gridley and A. H. Human, published in the "Journal of the Institute of Electrical Engineers," England, gives a summary of the power-plant expansion in England during the war. Power stations supplying railways or tramways only and private plants are not included.

One hundred and three municipal and 33 company-owned power stations were extended or built. The plant capacity of 327 municipal undertakings increased from 705,000 kw. installed at June, 1914, to 1,490,000 kw. installed or on order at Oct. 31, 1918. Similarly, some 230 company-owned power stations expanded from 430,000 kw. to 788,000 kw. The additional generating-plant capacity installed or ordered during the war therefore aggregated 1,143,000 kw., which is almost exactly equal to the total plant capacity existing when the war broke out.

The capital outlay involved on these extensions, with additions to main stations and substations, was approximately £23,000,000. Before the war the average size of generating units installed was 522 kw. and the largest unit in operation was of 8000 kw. capacity. The average size of units on order Oct. 31, 1918, was 7044 kw., and units of 25,000 kw. and 30,000 kw. were being built. The kilowatt-hours sold during the year ended June 30, 1914, were 2,100,000,000. For the year ended Dec. 31, 1917, there were 3,520,000,000. It can be assumed that the output for 1918 was nearly double that of 1914. The coal consumption per unit sold in 1914 was 4.1 lb. In spite of the very inferior fuel used in 1918 in comparison with 1914, the coal consumption in 1918 fell to 3.75 lb. In 1918 the coal consumption in municipal stations was 4.17 lb. per unit, and in company stations 3.17 lb. In 1918 the load factor of all the municipal stations combined was 28 per cent, and of all the company stations, 33 per cent. The load factor of individual stations varied widely. On Dec. 31, 1918, the municipalities had 237,000 kw. of load awaiting connection and the companies, 121,000 kw. The kilowatt-hours obtained other than by coal-firing were: Oil fuel, 50,000,000; waste heat and gas, 215,000,000; water power, 23,000,000.

A Method of Checking the Alignment of Diesel-Engine Shafts*

By George E. Windeler

It being generally conceded that the alignment of an engine, and especially of the shaft, is a most important factor in satisfactory operation, a simple method of checking this alignment is desirable. This checking should be applied from time to time after the engine is operating and therefore the method proposed should be easily applied without dismantling the engine.

The crankshaft, formed as it is with large intermittent gaps, is a comparatively weak structure, and great care must be used not to strain it in handling during erection. After making sure that the bearing shells are accurately bedded, the shaft should be tested in its bearings for concentricity and roundness of its journals. After any errors are found and corrected, the gaps may be put on and the shaft is ready for operation. This is, of course, the proper method when the engine is being erected.

When the engine has been running for some time and an overhaul is being considered, questions to ask with regard to the crankshaft are: Is it being properly supported in its bearing? Are the bearings in a satisfactory condition? Are all the bearings, including the outboard bearings, in alignment with one another?

The first indication that the shaft is not being properly supported is excessive end play on the shaft with the flywheel running out of true. Since this end play often exceeds the thrust-collar clearance, it must be due to springing of the crankshaft for want of support, thus extending and contracting the shaft by opening and closing the gap between the crank webs. Quite interesting results were obtained by measuring this gap when the given crank was on the top and then

*Abstract of a paper and discussion read before the Diesel Engine Users' Association, London.

on the bottom center. If the bearing next the crank was low, the crank webs would close when the pin was on the bottom center and open when it was on the top center. If the outboard bearing was low, the weight of the flywheel would give the opposite effect. It can be determined from such measurements which bearing or bearings are low and approximately how much since in general the amount will be nearly equal to the difference in the readings at the top and bottom centers respectively.

The use of an inside micrometer for these measurements was found to require very skillful handling, but a point gage and feelers proved much more satisfactory. It is of course necessary to take repeated measurements from between the same points. This can be accomplished by making a slight indentation in the crack web to locate the point of the gage.

The question arose as to how much more the crankshaft would be distorted under operating pressures than when standing still. It was suggested that the full blast pressure be applied when measuring the crank web with the crank on the top center. This was objected to as dangerous to the man making the measurements.

Some objection was made to depending entirely on gaging between crank webs as a criterion for crankshaft-bearing alignment. It was claimed that this method would not accurately indicate eccentricity of journals. Also a great difference in web measurements is shown when taken with or without the flywheel in position. Further, a bearing seldom wears equally throughout its length. In this case the shaft will rest only on the high end and perhaps show very little change in web distance unless the gaging is done under full working pressure. Another objection was the difficulty of interpreting the readings when made on an intermediate crank, this objection of course having no standing when applied to outer bearings.

Large Gas Engines in German Iron and Steel Works*

By Cosmo Johns and Lawrence Ennis†

The report is a statement of facts and inference based on observations made in the occupied territories on the left bank of the Rhine. Regarding power, nothing was more suggestive or instructive than the use made of large gas engines. Blowing engines for the blast furnaces and for bessemer converters, and electric power generators were nearly always gas-driven.

In blast furnaces a large amount of fuel gas is generated as a byproduct. After being cleaned, this gas is used as fuel for heating the air which is blown to the furnaces and converters, and for the generation of power. In the case of power the gas may be used in internal-combustion engines. The over-all efficiency from fuel to power is greatly in favor of gas engines, and the number of large units installed in nearly every plant was a proof of their reliability.

The gas engines, ranging from 1500 to 5000 hp., were used as blowing engines, both for blast furnaces and for converters, and to drive generators. For the latter use they did not respond well to the fluctuating demands, and the usual practice was to install some steam-turbine-driven generators to assist the gas-driven generators, although the gas engine was the predominant partner.

As a further refinement, at the Volkingen works in the Saar Valley, a waste-heat boiler has been installed to utilize the heat of the exhaust gases of a 3000-hp. gas engine. This has been so successful that a second boiler installation is under way. It is suggested that the cooling water from the gas engine be used as feed for the waste-heat boiler.

The more the gas engine can be used for power and blast production the less will be the fuel consumption, from ore to finished steel, per ton of product, as there will be more gas available for furnace heating.

*Abstracted from a "Report on the Present Status of Fuel Economy in the German Iron and Steel Industry of the Occupied Territory on the Left Bank of the Rhine," read before the Iron and Steel Institute at the autumn meeting in September, 1919.

†Members of a commission appointed by the British government to investigate the German iron and steel industry in the occupied territory.

Spasmodic Safety Efforts and the Harm ful Results

By H. M. Webber†

The experienced "Safety" man knows that no good can come of occasional efforts at accident prevention. The important results obtained by the National Safety Council, the railroads and the various industries, have been possible only because of the constant and persistent efforts put forth.

When a brilliant start is made and then nothing done for months, the effect is about as successful as if the Allies had made only occasional efforts to stop the German armies.

In addition to the purely negative effect of no results, an intermittent safety campaign has positive harmful results. A well-presented accident prevention program will usually meet with response from workmen, because it is easy to show them that they have a vital interest in it. If, however, the employer drops the matter after a short time, the employees become disgusted and it is much harder to arouse their interest a second time. Safety work is principally a fight against bad habits, which are easy to form and hard to break, and in favor of good habits that are hard to form and easy to break. A habit once broken and then returned to is harder to break a second time.

It is not necessary to emphasize the importance of safety work. It is, however, very important to emphasize the necessity for its unbroken intensive continuation. Better no safety work at all than spasmodic safety work.

†Superintendent, Department of Claims, Chicago Telephone Co., Chicago.

*Abstract of paper read before the Eighth Annual Safety Congress of the National Safety Council, October, 1919.

Move to Nationalize Germany's Power Supply

A bill nationalizing the electric power of the German Empire is reported to be pending. Germany has over 4000 power establishments, and the splitting up of their activities is held to cause serious waste. The scheme is made imperative by the loss of the Saar coal fields and the obligation to supply coal to the Allies.

The water power, which is mostly to be found in South Germany, is primarily to serve local industries, but an agreement will be made with those generating electricity from coal in central Germany. Power stations belonging to states and municipalities would not be disturbed, but the large plants belonging to private capital would be taken over and nationalized by the central Government. According to the plan the Government would buy up shares, so that the present organizations can remain intact. The nationalized works are not to be considered as a source of revenue, as the government holds that cheap power for industry is more important than fiscal interest.

The private capital in electrical power works in Germany is estimated at one billion marks and the use of electrical power in that country has increased from 4.43 billion kilowatt hours in 1907 to 22 billions in 1917.

Fuel Oil in New York City

New York City fuel oil rules governing storage and use of fuel oils, and construction and installation of oil-burning equipment, have been adopted by the Board of Standards and Appeals of New York City, and such oils can now be used in buildings of the city in place of coal. A tentative draft of proposed rules governing storage and use of fuel oils and construction and installation of oil-burning equipment was drawn up during the summer, and after a number of public hearings amendments to the draft were submitted to fuel oil engineers and fire-prevention experts for their opinions. The rules were promulgated Nov. 11 and become effective Dec. 1, 1919. Persons desiring to make installations under these rules may obtain copies of them upon request at the office of the Board of Standards and Appeals, Municipal Building.

Plans for installations under the new rules can be filed with the Bureau of Fire Prevention, and permits can be obtained immediately for the necessary work and alterations required for installation of oil-burning equipment.

Interprofessional Conference to Be Held at Detroit

With the purpose of bringing together the professional men of the country in order to plan more effective relations and to act together on matters pertaining to the public good, an Interprofessional Conference is being called to meet at the Statler in Detroit, Nov. 28 and 29. The conference was suggested by the Post-War Committee of the American Institute of Architects, which was established to study the new obligations thrust upon the architectural profession by the war.

It is the hope of those fostering the movement to perpetuate to an appreciable degree the enthusiasm of the war-time service rendered to the public by the professional men of the nation. The subjects which might well come before such an interprofessional organization have been classified under three heads: (a) The Functions and Interrelations of Professional Organizations; (b) Relations of Professions to the Public; (c) Educational Obligations of the Professions.

The Detroit program provides for an opening session in which representatives of the various professions will give their views as to the desirable objects, scope, method of procedure and organization for an interprofessional body. Following this discussion, which will be opened by Thomas R. Kimball, president of the American Institute of Architects, the plan is to appoint a committee on plan and scope which will be asked to report on the succeeding day when, if necessary, both sessions will be devoted to a discussion of the committee's report and to the permanent organization of whatever type of body may be agreed upon.

To date, among others, representatives of the medical, legal, educational and construction professions have accepted membership on the organizing committee. It includes Dr. Alexander Lambert, president of the American Medical Association, New York; Thomas R. Kimball, president of the American Institute of Architects, Omaha; Calvin W. Rice, secretary of the American Society of Mechanical Engineers, New York; Frederick L. Ackerman, New York; Felix Adler, New York; Charles A. Beard, New York; Charles A. Boston, New York; N. Max Dunning, Chicago; Henry W. Hodge, New York; Robert D. Kohn, New York; Arthur D. Little, Cambridge, Mass.; Basil M. Manly, Washington; Milton B. Medary, Jr., Philadelphia; George A. McKean, Detroit; E. J. Mehren, New York; Frank A. Waugh, Amherst; and Charles H. Whitaker, Washington.

The office of the organizing committee of the Interprofessional Conference is at 56 West 45th St., New York City.

Engineering Section, National Safety Council

The Executive Committee of the National Safety Council, in acordance with the action of the Council at its annual meeting, Oct. 1, has approved the organization of an engineering section, the purpose of which shall be to bring together the civil, mechanical, electrical, mining and chemical engineers in the Council's membership, so that they may contribute more effectively toward the solution of the purely engineering problems encountered in safety work.

Persons applying for membership in the Engineering Section must be members of one of the five great national engineering societies or Canadian or European societies of equal standing or must have had at least ten year's experience in engineering work, including at least five years in responsible charge, a college degree being considered equivalent to two years' experience. For associate membership three years' experience is required; this will gradually be increased to six years.

The functions of the engineering section are stated as follows: (1) To help meet the technical demands of the various industrial sections and furnish them technical information as desired. (2) To perform technical services for the Council, on request of the Executive Committee, such as the developments of standards or participation therein; the solution, by inquiry or through research, of special engineering problems arising in safety work, and helpful coöperation with the American Engineering Standards Committee, the National Engineering Societies, the Bureau of Standards, the casual departments of underwriters' laboratories, etc. (3) To conduct one or more meetings as a part of the Annual Safety Congress, at which engineering problems shall be discussed. (4) To conduct, if considered desirable, one or more additional sectional meetings during the year or in different localities. (5) To carry on such other activities as will, in the opinion of the Executive Committee of the National Safety Council, promote the safety movement and the best interests of the Council.

Two Thousand New Members for W. S. E. in One Week

From Oct. 4 to 10 inclusive the Western Society of Engineers conducted an intensive drive for new members. The goal was 2000 new members in a week, and almost exactly that number was added to the roll. A campaign organization consisting of an executive committee and fifteen teams of ten men each, directed by F. C. Barber, a professional organizer, was responsible for the results. Chicago engineers, architects, chemists, public-utility officials and a few business men interested in engineering are included in the list.

War experience had emphasized the need of coöperation among engineers and the value of one big local association that would link all engineers together for effective work, effective not only in numbers but in influence on local engineering affairs and in the upbuilding of the profession. The Western Society is now the big local association that was desired. There are progressive plans for the future in which local team work will count, and one of the first and biggest is an adequate engineering building for Chicago. A more active participation in civic affairs involving engineering, definite action in professional and welfare problems, more extended coöperation with national and other local societies, group courses in specific subjects, expansion of the engineering library, are some of the plans of the board of directors to benefit the members and to maintain their interest, to increase the prestige and standing of engineers in Chicago and by so doing elevate the profession to a higher plane of usefulness and service. It is a worthy work well started, and developments should prove of exceptional value to other cities planning a similar movement.

Fuel-Oil Stations for American Ships

The United States possesses a fleet of 486 oil-burning steel steamships representing 3,798,733 deadweight tons of new construction. In addition there are 49 freighters of the oil-burning type which have been reconveyed by the Shipping Board to their American owners and still another group of 18 which have been sold by the board and which are under the American flag. Of the 720 steel vessels under construction and contracted for, 636 are oil burners, these aggregating 4,691,659 deadweight tons. When the steel program has been completed, there will be a total of 1731 of the oil-burning type under the American flag.

American steamships can soon make a circuit of the world without the need of taking fuel at other than American-owned fuel stations. This applies to vessels steaming east from the Atlantic Coast or west from the Pacific seaboard.

The task was to find suitable places for the establishment of fuel stations along the trade lanes or adjacent to them. At the Panama Canal, the turn at the world's crossroads, facilities already existed and only required to be amplified. To take care of the east coast trade of South America, a station was erected at St. Thomas. This station, which had an initial capacity of 15,000 tons of storage, was opened on Oct. 2. Arrangements have been made for establishing a station at the Azores and another at Bizerta, a small French island off Tunis and located on the ocean-highway to the Indies. Material has been assembled at Manila, where another large storage tank is to be erected.

The total requirements for the United States merchant marine in 1919 have been estimated at 31,000,000 barrels.

Personals

E. Cort Magens, formerly with H. Belfield Co., is now director of sales with Pratt & Cody Co., Hartford, Conn.

E. J. Bell has been elected secretary and treasurer of the Frederick Engineering Co., Frederick, Md.

O. J. Gasche has been appointed manager of the Chicago branch office of the Springfield Boiler Co., 651 Marquette Building.

The F. H. Niles & Co., Inc., announces the appointment of F. H. Crawford as secretary and J. E. Haetten as sales manager of the company.

F. W. Leahy has resigned from the Emergency Fleet Corp. to assume charge of the marine department of the Diamond Power Specialty Co., Detroit, Mich.

Louis H. Egan, who was assistant general manager of the Union Electric Light & Power Co., St. Louis, Mo., has been elected one of its vice presidents.

C. W. Cross has been appointed by the Chicago Pneumatic Tool Co. as manager of western railroad sales, with headquarters at Fisher Building, Chicago.

F. R. Wadleigh has become associated with the Weston Dodson & Co., Inc., Dodson International Coal Corp., New York City, as consulting and expert engineer.

Harry T. Calkins is a new addition to the sales force of the Tacony Steel Co. He will be attached to the New York office but will sell in Connecticut exclusively.

G. P. Goodman, who for several years has represented the Hisey-Wolf Machine Co. in the East, went with F. H. Niles & Co., Inc., on Oct. 1, to take charge of its portable tool department.

W. A. Riddell has been elected president of the newly incorporated firm of the Frederick Engineering Co., Frederick, Md. Mr. Riddell is also president of the Frederick (Md.) Iron & Steel Co.

Harold P. Childs, formerly with the Westinghouse Machine Co., East Pittsburgh, Pa., is now vice-president and manager of sales of the Frederick Engineering Co., Frederick, Md.

Harry William Waterfall and Paul James Kiefer have been appointed assistant professors of mechanical engineering and steam engineering respectively in the College of Engineering of the University of Illinois.

F. L. Converse, formerly plant engineer of the Tacony Ordnance Corp., at Philadelphia, is now connected with the engineering department of E. I. Du Pont de Nemours & Co., at Wilmington (Del.) office.

C. F. Herington, formerly mechanical engineer of the Bonnot Co., Canton, Ohio, is now district manager of the Chicago office of the same company with office at Room 882, Continental & Commercial National Bank Building.

S. J. Andres has resigned as electrical engineer of the Kellogg Toasted Corn Flake Co., Battle Creek, Mich., to connect with some progressive coal company or open an office of his own. He is now at Prescott, Ark.

F. G. Rogers has been appointed manager of the Chicago office of the Under-Feed Stoker Co. of America in place of F. M. Smith, resigned. Mr. Rogers has been attached to the Chicago office in the capacity of sales engineer since 1916 and will be located at the present office of the company, 521-523 Harris Trust Building.

Edwin Lundgren, who was formerly chief engineer of the stoker department of the Westinghouse Machine Co., and consulting engineer of the Westinghouse Electric and Manufacturing Co., is now vice-president and chief engineer of the newly incorporated firm of the Frederick Engineering Co., Frederick, Md.

H. W. Price, of Frostburg, has succeeded V. St. C. Montieth as the Martinsburg (W. Va.) manager of the Potomac Power Co. Mr. Price was formerly connected with the Frostburg Illuminating and Manufacturing Co., and the Edison Lighting Co., of Cumberland. Prior to that he was with the W. L. Doherty Co. Mr. Montieth has been promoted to a superintendency of the various plants of the company and will make his headquarters in Hagerstown.

Wm. L. DeBaufre has been appointed professor of mechanical engineering at the University of Nebraska, resigning the position of designing engineer of the Precision Instrument Co. of Detroit. He will still act as consulting engineer for this firm and others on development and research problems in engineering and industrial measurements and processes. Prof. DeBaufre was mechanical and electrical engineer for over seven years at the U. S. Naval Engineering Experiment Station, Annapolis, Md., where he had charge of important investigations on fuels, power plant and refrigerating machinery, and engineering instruments. He is the inventor of the regenerative evaporator system and the orifice method of operating evaporators controlled by the Griscom-Russell Co. of New York.

Engineering Affairs

The American Society of Mechanical Engineers announces the following Section meetings: Atlanta, Ga., Nov. 25; Cleveland, Ohio, Nov. 25, in the rooms of the Cleveland Engineering Society, Roof Garden, Hotel Statler.

The Associated Manufacturers of Water Purifying Equipment, organized during the war, has become a permanent organization. Its work will consist largely of standardization of equipment sizes, of guarantees to customers and of terms of sales. The first meeting of the association to be held in the West, will be held at the Hotel Fontenelle, Omaha, Neb., Nov. 17.

The American Society of Mechanical Engineers will hold its fortieth annual meeting at the Engineering Societies Building, 29 West 39th St., New York City, Dec. 2-5. The following is a partial list of the papers to be presented: "Common Errors in Designing and Machining Bearings," by C. H. Bierbaum; "Turbo-Compressor Calculations," by A. H. Blaisdell; "A Perfected High-Pressure Rotary Compressor," by C. B. Lord; "Modern Electric Furnace Practice as Related to Foundries," by W. E. Moore; "Scientific Development of the Steam Locomotive," by John E. Muhfeld; "An Investigation of Strains in the Rolling of Metal," by Alfred Musso; "A New Type of Hydraulic-Turbine Runner," by Forrest Nagler; "Appraisal and Valuation Methods," by David H. Ray; "Kerosene as a Fuel on High-Speed Engines," by L. F. Seaton; "Oil Pipe Lines," by S. A. Sulentic; "Lubrication of Ball Bearings," by H. R. Trotter; "Thread Forms for Worms and Hobs," by B. F. Waterman; "Octaval Notation and the Measurement of the Binary Inch Fractions," by Alfred Watkins; "Motor Transport Vehicles for the U. S. Army," by John Younger; "Air Pumps for Condensing Equipment," by F. R. Wheeler.

The American Association of Engineers, executive committee, has rendered a decision that the constitution of the association does not prohibit the admission of architects, and announces that the applications of architects will be considered hereafter in the same status as applications from engineers. Those architects who have previously applied for membership and whose applications could not be accepted on account of the apparent exclusion of architects by the constitution, may now re-enter their applications for membership.

The association announces the appointment of the following chairmen of national committees for the ensuing year: Americanization, Garrison Babcock, consulting telephone engineer, Chicago; Education, Prof. Frederic Bass of the University of Minnesota, Minneapolis; Ethics, Isham Randolph, consulting engineer, Chicago; Finance, Glen Vivian, Accounting Department, Bureau of Statistics, Chicago, Milwaukee and St. Paul R. R., Chicago; Highway, R. C. Yeoman, chief engineer, Indiana Sand and Gravel Association, Indianapolis; Legislation, W. H. Whipple, chief engineer, Lime Association, Washington, D. C.; Membership, R. W. Barnes, principal assistant engineer, Southern Pacific Ry., Portland, Oregon; Municipal Engineering, S. C. Hadden, editor of Municipal and County Engineering, Chicago; Practice, H. W. Clausen, general office manager, C. D. Osborne Co., Chicago; Program, L. Winship, assistant engineer, Missouri Pacific R. R. Co., St. Louis, Mo.; Public Relations, L. K. Sherman, president of the United States Housing Corp., Washington, D. C.; Publications and Publicity, W. W. Horner, chief engineer, City of St. Louis; Qualification, A. C. Irwin, engineer, Structural Bureau, Portland Cement Association, Chicago; Salaries of Engineers in Public Service, A. N. Johnson, consulting highway engineer, Portland Cement Association, Chicago.

Business Items

Reeds and Thorpe, power engineers, have been organized with offices at 904 Main St., Hartford, Conn.

The United Electric Construction Co., Inc., has opened a branch office at 558-559 Hippodrome Annex, Cleveland, Ohio.

The Sanford Riley Stoker Co. announces the appointment of M. G. Brennan as district engineer in the Western territory and W. Mather as district engineer in the East.

The Poole Engineering & Machine Co., Baltimore, Md., has opened a branch office in the Old South Building, Boston, Mass., with Robert W. Catlin as district manager.

Starkweather & Broadhurst, Inc., Boston, Mass., has opened an office in the Third National Bank Building, Springfield, Mass., with W. P. Alexander, formerly of the Providence Engineering Works, in charge.

The Baber-Greene Co., Aurora, Ill., recently began work on the construction of a 180 x 90 ft. addition to its factory. This is the second time this year that additions have proved necessary in keeping up with orders. The new building will be used as the assembly department and will be modern throughout.

The Montrose Metal Roofing Co., of Camden, N. J., has been purchased by M. Sheffler and Samuel Gross, of Philadelphia, the former being president and the latter treasurer of the company. They have also started another company under the name of Montrose Metal Products Co., to do a general metal stamping business at Camden.

Parsons-Moorehead Machinery Co., Hostetter Building, 237 Fourth Ave., Pittsburgh, Penn., has been organized to do a general machinery business. Mr. William L. Moorhead of this company was formerly vice-president of the Duquesne Electric & Manufacturing Co., while Mr. Parsons has been doing a general machinery business for several years. Both men are well known in the trade.

Trade Catalogs

The Medart Patent Pulley Co., Inc., St Louis, Mo., has issued a 16-page booklet illustrating and describing Medart friction clutches. A copy may be had free upon application.

The Barber-Greene Co., Aurora, Ill., has published a 32-page catalog, No. 3, on B-G Standardized Belt Conveyors. This catalog fully describes and illustrates the company's standardized material handling machines, portable and stationary belt conveyors and self feeding bucket loaders A copy may be had free upon request.

The Metal & Thermit Corp., New York City, has issued a folder entitled "How Thermit Cured my Diseased Neck," which illustrates a thermit welding repair, consisting of building up with thermit steel the worn pods on the end of the 16 inch diameter neck of a large roughing mill pinion.

Lea-Courtenay Co., Newark, N. J., has recently issued two new bulletins—one, termed H-4, is a treatise on centrifugal pumps as well as a catalog of the company's most complete line. The other bulletin, S-5, is a synopsis of typical centrifugal pumps installed in various industries, showing the wide range of pumping service which Lea-Courtenay centrifugal pumps cover. A copy of either of these bulletins may be had on application to the company.

The Heine Safety Boiler Co., St. Louis, Mo., has recently completed the printing of "Marine Boiler Logic," a 69-page booklet dealing with the fundamental design of marine cargo carriers. The booklet was written by Chas. H. Stoddard, consulting marine engineer of the Heine Company. The main part of it relates to the design and construction of Scotch and water tube boilers for marine purposes. Evaporative capacities are worked out for the two types, using coal or oil as fuel, with natural or forced draft. It also contains a discussion of power and speed of cargo vessels. The last part of the booklet is devoted to a description of the construction and operation of the cross-drum type of water tube boiler developed by the Heine Company for marine service.

New Construction

PROPOSED WORK

Mass., Springfield—The United Manufacturing Co., 57 Willow St., will construct a 1 story addition to its present machine shop, also a 1 story boiler house, on Bernie Ave. Estimated cost, $25,000. Work will be done by day labor.

N. Y., Auburn—McIntosh & Seymour, 91 Orchard St., are in the market for pumps for marine boilers.

N. Y., Norwich—Tooker & Marsh, Arch., 101 Park Ave., New York City, will receive bids about January 2 for the construction of a grade and high school, for the Board of Education. A steam heating system will be installed in same. Total estimated cost, $250,000.

Pa., Altoona—The Board of Directors authorized C. M. Piper, Secy. of the Board of Education, to engage engineers to draw up plans for a plant to furnish light, heat and power to Altoona High, Central, Grammar and Emerson Schools. The plant is to supply power to the buildings located within a radius of the city block. Total estimated cost, $100,000.

Pa., Philadelphia—The Sun Shipbuilding Co., Finance Bldg., 1426 Penn. Sq., is in the market for 200-250 h.p. locomotive type boilers.

Va., Norfolk—Fenorstein & Co. is having plans prepared by R. E. Mitchell & Co., Arch., Flatiron Bldg., for the construction of a 5 story, 180 x 250 ft. ice and cold storage building.

N. C., Garland—The White Lake Lumber Co. is in the market for a feed water heater for an 825 h.p. boiler.

Fla., Vero—The Vero Utilities Co plans to install a 75 h.p. engine and generator in its electric light plant here. Electric lines will also be extended.

Ohio, Cleveland—The Capital Amusement Co. will receive bids about December 15 for the construction of a 2 story, 100 x 160 ft. motion picture theatre on East 117th St. and Kinsman Rd. A steam heating system will be installed in same. Total estimated cost, $100,000.

Ohio, Cleveland—The City Ice Delivery Co. will soon award the contract for the construction of a 1 story 28 x 70 ft. ice storage building and a 1 story, 22 x 24 ft. engine room, at Station 4, Madison Ave. Total estimated cost, $25,000. Harry I. Norvall, Cadillac Bldg., Pres. C. C. Coneby, Cadillac Bldg., Arch. and Engr.

Ohio, Elyria—The city will receive bids in December for building a complete waterworks system, including 1,000,000 gallon pump, two 300 h.p. boilers, filter house and 9 mi. of 60 in. water main. Total estimated cost, $1,000,000. Morris Knowles, Jones Law Bldg., Pittsburgh, Penn., Engr. Noted Sept. 30.

Ohio, Lakewood—W. R. Powell, Arch. and Engr., Rose Bldg., Cleveland, will receive bids about December 18 for the construction of a 1 story, 80 x 240 ft. market house on Detroit Ave., for the Lakewood Market House Co., c/o architects. A steam heating system will be installed in same. Total estimated cost, $250,000.

Mich., Jackson—The Hup Motor Co. plans to build a 1 story, 60 x 90 ft. power house, to include 2 vertical type boilers, engine, fan, pumps, etc. Smith, Hinchman & Grylls, 710 Washington Arcade, Detroit, Arch. and Engr.

Ill., Oak Park—The Board of Education will soon award the contract for the construction of a 4 story, 144 x 157 ft. high school. Project will include an addition to the present heating plant in the old building. Total estimated cost, $150,000. Holmes & Flinn, 8 South Dearborn St., Chicago, Arch.

Wis., Colfax—J. C. Jacobson, Engr., Metropolitan Bldg., Minneapolis, Minn., will soon award the contract for the construction of a power house, diversion dam, headrace and equipment on Red Cedar River, for the Colfax Electric Co. Total estimated cost, $100,000.

Ia., Maquoketa—The city will soon award the contract for the construction of a complete electric plant, to include a 250 h.p. oil engine, generator, exciter, switchboard, 12,000 gallon oil tank, distribution line, transformers and meters. G. O. Morse, Supt.

Minn., Duluth—M. S. Cook, 317 East 3rd St., will receive bids until January 1 for the construction of a 2 story, 118 x 140 ft. theatre on West Superior St., for the Cook Enterprise Co., 313 West Superior St. Steam heating and mechanical ventilating systems will be installed in same. Total estimated cost, $500,000. Rupp & Rupp, Chicago, Ill., Arch. and Engr.

Minn., Duluth—The McDougall Duluth Co., 85th Ave., W., is in the market for high pressure pump, 1 vertical complex pump, 1 general service pump, 1 low pressure pump, 1 main circulating pump and 1 centrifugal pump.

Kan., Valley Center—The city will soon award the contract for furnishing two 60 gallon plunger pumps with motors and constructing two 12 in. wells with derricks and pump houses, etc. Ruckel Engineering Co., Hutchinson, Engr.

Neb., Omaha—The Omaha Cold Storage Co., 8th and Farnam St., will soon award the contract for the construction of a 5 story 132 x 154 ft. addition to its plant. Total estimated cost, $250,000. B. H. Gibson & Co., 608 South Dearborn St., Chicago, Arch.

Mo., Kirksville—The city is having plans prepared for improvements to the water works system, including one 100 h.p. water tube boiler, two 100 h.p. oil engines, two 600 G. P. M. centrifugal pumps, etc. Total estimated cost, $30,000. W. B. Rollins & Co., 209 Railway Exchange Bldg., Kansas City, Mo., Engr.

Colo., Lamar—The Town Council will soon award the contract for the construction of a water works system, also an electric light plant, consisting of general power plant supplies, engines, generators, boilers, pumps, etc. Total estimated cost, $200,000. Royal D. Salisbury, 1415 Colfax Ave., Denver, Engr.

Colo., Peetz—The Town Council will soon award the contract for furnishing material and labor for additions and extensions to the pumping plant, consisting of two 35 h.p. internal combustion oil engines, two 2300 volt generators for direct connection to the above, one switchboard, one deep well pump for 500 ft. head, pumping station accessories, etc. Total estimated cost, $25,000. Royal D. Salisbury, 1415 East Colfax Ave., Denver, Consult. Engr.

Ore., Eugene—The Eugene Fruit Growers' Association plans to build a 2 story, 50 x 50 ft. artificial ice plant addition. Estimated cost, $8000. J. O. Holt, Mgr.

Ore., Vale—The Shattuck-Edinger Co. is having inspections made, preliminary to extending Nevada Irrigation Ditch, installing pumping plant, enlarging the mill ditch to capacity sufficient to carry the Gellerman-Froman Ditch water from Willow Creek pumping to Nevada Ditch diversion. Total estimated cost, $75,000. J. Lewis, Mgr.

Cal., Richgrove—The Southern California Edison Co., Edison Bldg., Los Angeles, plans to construct a 43,000 h.p. hydro electric system, dam, tunnels and fumes to divert 600 cu. ft. water per second from North Fork of Kern River, Tulare County, to company's sub-station here. Total estimated cost, $9,231,358.

Cal., Santa Barbara—The Southern Counties Gas Co., 724 Spring St., Los Angeles, plans to extend its compressor and boiler house here. Estimated cost, $4000. J. D. Thompson, Chief Engr.

Cal., San Diego—The Bureau of Yards & Docks, Navy Department, Washington, D. C., will receive bids until November 19 for the construction of a central building, consisting of a power house, etc., at the Marine Corps Base here. Estimated cost, $200,000.

Alaska, Petersbury—The City Council adopted a resolution to purchase a site adjoining the city, near the lake, and build a 5000 h.p. hydro-electric power plant. Estimated cost, $75,000.

Hawaii, Pearl Harbor—The Bureau of Yards & Docks, Navy Department, Washington, D. C., received bids for the construction of a power plant at the naval station here, from Adams Bretz & Co., 1959 Park Ave., New York City, $84,321; John W. Danforth, 72 Ellicott St., Buffalo, N. Y., $105,216; Stewart Engineering Corporation, 61 Broadway, New York City, $117,471. Noted September 30.

Ont., Toronto—The Hydro-Electric Power Commission of Ontario, University Ave., plans election in January to vote on by-law for $8,360,000, to build 48 miles railway from here to Bowmanville (80 lb. track), to include transmission line 48 miles long. Scarboro Township will appropriate $900,000 and Pickering Township $300,000 toward cost. F. C. Gaby, University Ave., Engr.

Ont., Wingham—The town voted $40,000 bonds, thereby authorizing the Hydro-Electric Power Commission of Ontario to build a power plant and distribution system. Plans include 30 miles of power line from here to Eugenia Falls. F. A. Gaby, Hydro Bldg., Toronto, Engr. Noted July 8.

CONTRACTS AWARDED

Conn., New Haven—The Edward Malley Estate, 902 Chapel St., has awarded the contract for the construction of a 2 story boiler and engine room on Temple St., to the Larkin Carey Co., 166 Brewery St. Estimated cost, $30,000.

N. Y., New York—The Uneeda Ice Co., Inc., 666 East 187th St., has awarded the contract for the construction of a 3 story, 74 x 90 ft. ice plant on Jumel Pl. and 167th St., to the Lustbader Construction Co., 103 Park Ave.

Pa., Philadelphia—The Breyer Ice Cream Co., 8th and Cumberland St., has awarded the contract for the construction of a 1 story, 50 x 78 ft. boiler house, on 8th and Cadwallader St., to W. F. Koelle & Co., 26 Oxford St. Total estimated cost, $10,000.

Md., Annapolis—The Bureau of Yards & Docks, Navy Department, Washington, D. C., has awarded the contract for the construction of a power house addition, an ash bunker, to Levering & Garrigues, 552 West 23rd St., New York City, $81,877. Noted September 30.

Md., Baltimore—The Consolidated Gas, Electric Light & Power Co., Lexington Bldg., has awarded the contract for the construction of a 2 story, 53 x 58 ft. electric power service building, at Westport, to Arthur Tufts, 1401 Lexington Bldg. Total estimated cost, $50,000.

Md., Silver Run—A. W. Feezer has awarded the contract for the construction of a power house, canning factory and corn storage building to the Roystone-Craig Engineering Co., Westminster. Total estimated cost, $50,000.

Ky., Ashland—The Board of Water Commissioners has awarded the contract for the construction of a centrifugal pumping plant, to consist of 7 units, to J. E. Nelson & Sons, 117 North La Salle St., Chicago, Ill.

Ohio, Cleveland—The Board of Education, 1663 Lee Rd., has awarded the contract for the installation of feed water pumps and 2 Hart boilers, in the proposed 2 story, 110 x 176 ft. school addition on Roxboro Rd., to Chappell-Warren Co., 1830 St. Clair Ave. Total estimated cost, $400,000. Noted January 7.

Ohio, Cleveland—The Board of Education, 6th St. and Rockwell Ave., has awarded the contract for the installation of a boiler, radiators, piping, valves and ventilating system, in the proposed 3 story, 83 x 139 ft. public school addition on Miles Ave., to the Miles Heating & Ventilating Co., Park Bldg. Total estimated cost, $250,000.

Ohio, Cleveland—Friedman Blau Farber Co., East 37th St. and Perkins Ave., has awarded the contract for the construction of a 1 story 45 x 60 ft. boiler house to C. N. Griffen, 5509 Euclid Ave. Estimated cost, $50,000.

Ohio, Cleveland—The Prame Realty Co., 214 Williamson Bldg., has awarded the contract for the construction of a 4 story, 107 x 140 ft. commercial building on 27th St. and Payne Ave., to Craig Curtiss Co., 1030 Guardian Bldg. A steam heating system, including two 150 h.p. boilers, stokers, generator, etc., will be installed in same. Total estimated cost, $250,000.